ENGINEERING EXPERIMENT STATION

BULLETIN 487

MEDIANS OF DIVIDED HIGHWAYS — FREQUENCY AND NATURE OF VEHICLE ENCROACHMENTS

by

John W. Hutchinson
Associate Professor of Civil Engineering,
University of Kentucky

Thomas W. Kennedy
Assistant Professor of Civil Engineering,
University of Texas

Price: $3.00

Prepared as a part of an investigation
conducted by
The Engineering Experiment Station
University of Illinois
in co-operation with

The State of Illinois
Division of Highways
and
The U.S. Department of Commerce
Bureau of Public Roads
Project IHR-59
Widths and Cross Sections for
Medians of Divided Highways

Illinois Cooperative Highway Research Program
Series No. 53

Edited by
Ann C. Riggins

REQUESTS FOR THIS PUBLICATION should be addressed to Engineering Publications Office, [illegible] Engineering Hall, University of Illinois, Urbana 61801. On your order refer to the Bulletin number on the front cover.

UNIVERSITY OF ILLINOIS BULLETIN

Volume 63, Number 123; June 6, 1966. Published twelve times each [illegible] by the University of Illinois. Entered as second-class matter December [illegible] 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 114 Altgeld Hall, Urbana, Illinois 61801.

ABSTRACT

THE FREQUENCY, NATURE, AND CAUSES OF VEHICLE ENCROACHMENTS ON MEDIANS OF DIVIDED HIGHWAYS WERE INVESTIGATED TO OBTAIN INFORMATION NEEDED IN ESTABLISHING TRAFFIC SAFETY CRITERIA FOR MEDIAN WIDTH AND CROSS SECTION DESIGN. THE EFFECTS OF MEDIAN WIDTH AND CROSS SECTION TRAFFIC VOLUME, ROADWAY ALIGNMENT, WEATHER, ROADWIDE SIGNS, GRADE SEPARATION STRUCTURES, AND OTHER FEATURES OF THE HIGHWAY AND DRIVING ENVIRONMENT WERE CONSIDERED. RELATIONSHIPS BETWEEN TRAFFIC VOLUME AND THE FREQUENCY AND NATURE OF VEHICLE ENCROACHMENTS ON MEDIANS ARE PRESENTED.

THE RECOMMENDATIONS INCLUDE MINIMUM DESIGN REQUIREMENTS FOR THE SAFE STOPPING OR CONTROL OF VEHICLES IN THE MEDIAN. IT WAS CONCLUDED THAT FLATTER MEDIAN CROSS SLOPES SHOULD BE EMPLOYED AS A MEANS OF (1) DECREASING THE MAXIMUM LATERAL EXTENT OF MOVEMENT OF ENCROACHING VEHICLES AND (2) DECREASING THE FREQUENCY OF ERRATIC VEHICLE REENTRY TO THE TRAFFIC STREAM. CULVERT HEADWALLS, DRAINAGE INLET STRUCTURES, EARTHEN DITCH-CHECKS, CROSS-OVER EMBANKMENTS, AND OTHER SUCH OBSTACLES WERE FOUND TO SERIOUSLY LIMIT THE VALUE OF THE MEDIAN AS A SAFE VEHICLE STOPPING OR RECOVERY SPACE. IT IS RECOMMENDED THAT SUCH MEDIAN APPURTENANCES BE DECREASED TO THE SMALLEST PRACTICAL NUMBER AND DESIGNED SO AS TO PRESENT THE LEAST POSSIBLE HAZARD TO THE PASSAGE OF VEHICLES ENCROACHING UPON THE MEDIAN AT NORMAL HIGHWAY OPERATING SPEEDS. STUDY OF CAUSES OF ENCROACHMENTS INDICATES (1) THAT CURVES, APPROACHES TO CURVES, AND AREAS IMMEDIATELY DOWNSTREAM FROM GRADE SEPARATION STRUCTURES SHOULD BE AVOIDED AS LOCATIONS FOR LARGE ROADSIDE SIGNS AND (2) THAT MORE EMPHASIS SHOULD BE PLACED ON LANDSCAPE PLANTING TO IMPROVE DELINEATION OF ROADWAY ALIGNMENT.

This page is intentionally blank.

ACKNOWLEDGMENTS

This research was undertaken in July, 1958, by the Engineering Experiment Station of the University of Illinois in co-operation with the Illinois Division of Highways and the U.S. Bureau of Public Roads.

The work carried out by the University was under the general administrative supervision of W. L. Everitt, Dean of the College of Engineering; Ross J. Martin, Director of the Engineering Experiment Station; N. M. Newmark, Head of the Department of Civil Engineering and Professor of Civil Engineering; and Ellis Danner, Director of the Illinois Cooperative Highway Research Program and Professor of Highway Engineering.

Virden E. Staff, Chief Highway Engineer; Theodore F. Morf, Deputy Chief Highway Engineer; and John E. Burke, Engineer of Research and Development, directed the administrative work for the Division of Highways of the State of Illinois.

Technical advice was provided by Project Advisory Committee members as follows:

Representing the Illinois Division of Highways:

John E. Burke, Engineer of Research and Development
W. E. Chastain, Sr., Engineer of Research and Development, (deceased)
W. A. Frick, Engineer of Location and Roadway Planning
Albert Sifrer, Assistant District Engineer of Design

Representing the U.S. Bureau of Public Roads:

F. G. Schmalz, Area Engineer, Illinois Division (Prior to November, 1959)
A. Taragin, Assistant Deputy Director, Office of Research and Development
A. E. Traeger, Area Engineer, Illinois Division (Since November, 1959)

Representing the University of Illinois:

J. E. Baerwald, Professor of Traffic Engineering
J. F. Kamman, Associate Professor of Psychology

The assistance provided by Professors Milton H. Crothers and Gordon Gracie and by Messrs. Ward R. Malisch, Louis T. Cerny, and Robert G. Starkey in data collection and analysis is gratefully acknowledged.

Appreciation is extended to the reviewers of this Bulletin: W. A. Frick, Engineer of Location and Roadway Planning, Illinois Division of Highways; Stanley R. Byington, Highway Research Engineer, U.S. Bureau of Public Roads; and K. A. Stonex, Executive Engineer, Automative Safety Engineering, General Motors Technical Center.

This page is intentionally blank.

CONTENTS

FIGURES

MAPS

TABLES

This page is intentionally blank.

GLOSSARY

median	= an essentially continuous street or highway element, ranging in width from a narrow painted line to several hundred feet, located between the opposing traffic streams on the facility, and not intended as a path of continuous travel for traffic. (Defined by the American Association of State Highway Officials as "the portion of a divided highway separating the traveled ways for traffic in the opposing directions.")
encroachment	= the travel of a vehicle on roadway areas outside the limits of the designated lane(s) of travel. Refers to encroachment on the median in this report.
median encroachment rate	= the number of vehicle encroachments on the median per 100 million vehicle-miles of travel (both directions of travel).
encroachment frequency	= the number of vehicle encroachments on the median per mile of highway per year (both directions of travel).
average daily traffic (ADT)	= the average 24-hour traffic volume determined in this study by averaging the traffic counts taken at both ends of the highway section over a one-week period.
expanded 15-minute volume	= average 24-hour traffic volume which would result if the one-directional volume of traffic for a given 15-minute time interval were to occur in every 15-minute interval during the day for most directions of travel.

encroachment angle = the angle between the pavement edges and the path of the left front tire of the encroaching vehicle at the point the vehicle leaves the pavement.

recovery-to-right (recovery) = the point in an encroachment pattern at which the lateral velocity component changes sign due to the driver's steering through a horizontal curve to the right.

length of travel during encroachment = the distance from the point the encroaching vehicle runs off the pavement to the point at which it stops or leaves the median area as measured along the path of the left front tire.

initial length of travel = the length of travel to the first point of vehicle recovery in the median.

lateral extent to movement = the perpendicular distance from the left edge of the pavement to the path of the left front wheel of the encroaching vehicle at the point of maximum departure from the pavement.

initial lateral extent of movement = lateral extent of movement at the first point of vehicle recovery in the median.

shallow encroachment = an encroachment in which the lateral extent of movement is less than 3 feet.

caravaning = the tendency for drivers of vehicles in a traffic stream to follow one another, orienting their vehicles laterally and longitudinally with respect to the vehicles ahead.

This page is intentionally blank.

I. INTRODUCTION

This is the final report on Illinois Cooperative highway Research Project 59, 'Widths and Cross Sections for Medians of Divided Highways." Work on this project has been directed toward providing a more complete framework of knowledge within which the designer can obtain a perspective of the factors affecting decisions to be made in median design. Primary effort has been devoted to seeking "information needed for median design to achieve optimum safety and service to traffic" as covered in the first four items in the right-hand column of the outline below.

- Information needed for median design to achieve
  - optimum safety and service to traffic by
    - decreasing the rate of vehicle encroachment on roadside areas:
      - (1) The extent to which median width and cross section can and should reduce headlight glare
      - (2) The extent to which median width and cross section can and should delineate roadway alignment
    - providing suitable stopping and recovery space for encroaching vehicles:
      - (3) The effects of median appurtenances on the safety of vehicle encroachment on the median and the extent to which this hazard can and should be decreased
      - (4) The width and cross section needed for the stopping and recovery of encroaching vehicles and the prevention of cross-median accidents
  - maximum practical economy in regard to
    - right-of-way:
      - (5) Right of way costs attributable to providing medians of various widths and the economy of providing space for future traffic lanes in the median
    - construction:
      - (6) The effects of median widths and cross section on the costs of initial construction and future construction to increase capability
    - maintenance:
      - (7) The effects of median width, cross section, surfacing, and appurtenances on the cost of repairs (accident damage) and routine maintenance (mowing, pruning, painting, trash removal, snow and ice control, etc.)

Item 1 is the subject of a current Illinois Cooperative Highway Research Project, "An Investigation of Tolerable Levels of Headlight Glare as Related to Median Performance," which was begun in 1964. Items 5, 6, and 7 have not been subjected to concentrated study.

The ultimate objective of such studies is to determine desirable widths and cross sections for highway medians in both urban and rural locations in relation to safety, service to traffic, and economy.

The nature of this ultimate objective and the present lack of knowledge concerning median performance(1)* necessitate the development of many properly oriented and related studies to add to the gradually accumulating body of needed knowledge. These studies must provide needed improvement of interim median design procedures without sacrificing an orderly approach to the ultimate objective. A simultaneous analysis of all the factors of influence in median design would be too complex and inefficient because, as indicated by the long lists of median functions and limitations on median design,(1) almost all of the known variables in highway design are involved.

The most orderly approach to this ultimate objective is to direct initial efforts more toward the traffic operation aspects of the study than toward the capital cost and maintenance factors. This is appropriate not only because the greatest initial attention is thereby given to the most important median functions but also because the information obtained from the study of traffic safety and service benefits is essential to the development of a proper economic analysis. Until the most desirable widths and cross sections of median in relation to traffic safety and service are known, there is no appropriate starting point for altering the design of a median in consideration of such economic factors as right-of-way, construction, and maintenance costs.

The specific objective of the phase of study reported herein was to determine the frequency and nature of vehicle encroachments on certain types of medians under selected field conditions in order to evaluate the median's potential as a stopping or recovery space for erratically moving vehicles. Since the importance of designing the median as a stopping or recovery space for encroaching vehicles varies with the extent to which the frequency and nature of such encroachments can be controlled, particular attention was also given to factors causing or influencing encroachments. The study, therefore, included the investigation of the frequency, nature, and possible causes of vehicle encroachments.

*Superscript numbers in parentheses refer to entries in Chapter VII, References.

II. APPROACH TO THE PROBLEM AND SOURCES OF DATA

A. METHOD OF STUDY

In developing plans of this phase of the study it was assumed that conventional accident records would be of little value in determining either the frequency or nature of vehicle encroachments on medians. A subsequent comparison of accident records and project data provided support for this assumption.(2)

The main argument against the use of accident records as the primary source of data was that accident records give little indication of the extent to which a median is successful as a stopping or recovery space for erratically moving vehicles. The successful stopping or control of vehicles that have run into the median is seldom reported.

Accident records could perhaps provide an accurate measure of the frequency of failure of the median to serve as an appropriate vehicle stopping or recovery space. However, the limited amount of economically feasible police surveillance will probably always allow some undetected cross-median movements and some unreported minor collisions of vehicles with fixed objects in the median. Furthermore, the amount and type of police surveillance varies from time to time and from one location to another so that a small number of reported minor accidents at any given location cannot be construed to mean that only a few such accidents occurred there. Often it means that less police surveillance was provided or that the policing agency does not prepare formal reports for accidents involving less than a given amount of estimated damage or injury.

The chosen method of study consisted of a detailed analysis of the evidence at the site of each vehicle encroachment on the medians of the highway segments selected for the study.* This required carefully planned, weekly coverage of the entire lengths of the selected highway segments to locate and evaluate the evidence of vehicle encroachments. Frequently, more thorough surveillance was provided in order to avoid losing evidence due

*See Appendix A for summary of investigation of methods of vehicle encroachment detection.

to snow storms, melting snow, and the activities of maintenance personnel.

Surveillance was provided by two-man teams who patrolled the highway in specially marked, slow-moving vehicles. Prepared report forms were used in recording the data at each encroachment site (Appendix B). The record of each encroachment consisted of a sketch of the path of vehicular movement with dimensions, highway cross section dimensions, type of median cover, approximate time of occurrence, and other pertinent data. A visual record of each encroachment was compiled with a series of colored and black and white pictures. In order to avoid duplicate reporting during the three-and-one-half years of study on Federal Aid Interstate (F.A.I.) Route 74, each encroachment was assigned a number which was painted on the pavement at the encroachment site.

The frequency of vehicle encroachment on medians was determined from complete records of every incident involving vehicle travel in the median during a chosen time interval. Both urban and rural highway segments were included in this part of the study. The first data were obtained from Kingery Expressway in the Chicago area between December 1 and March 31 to utilize frequent snow cover in more readily locating the tire tracks made by encroaching vehicles. The rural highway data were obtained from F.A.I. Route 74 between Urbana and Danville, Illinois, from October 4, 1960, the date the highway was opened to traffic, to April 6, 1964.

The nature of vehicle encroachments upon the median was determined from data collected at the sites of the encroachments and from whatever additional pertinent information was contained in available accident reports. A data summary is presented in Appendix C. Because of the necessary accuracy and detail of the needed data, some observed locations of vehicle encroachments were excluded from this part of the study for insufficient evidence at the encroachment site. The data for this part of the study were collected from 24.6 miles of F.A.I. Route 74 between Champaign and Danville and from a portion of F.A.I. Route 57 in southern Illinois. Interstate Route 57 was included in the study in order to evaluate the 80-foot, double-ditch median used on portions of this highway. The analysis and findings are presented in Chapter IV.

The factors causing or influencing vehicle encroachments on medians were given considerable attention throughout the study. An analysis of the conditions at several points of high encroach-frequency on U.S. Route 66 was previously reported.(3) A similar analysis of 24.6 miles of F.A.I. Route 74 is included here as Chapter V.

Copies of state police reports for all accidents on U.S. Route 66 and F.A.I.

Routes 57 and 74 in Illinois were obtained directly from the district offices of the Illinois State Highway Police during the period of study. These reports were used considerably in analyzing certain details of accidents involving encroachment upon the median. They often provide a check of procedures used by project personnel in collecting data at vehicle encroachment sites.

All other data from accident records and most of the information concerning traffic volumes and maintenance activities were obtained from the Illinois Division of Highways. Some early difficulty was experienced in distinguishing between the tire tracks of maintenance vehicles and the tracks made by encroaching vehicles. Frequent contacts with maintenance personnel and a knowledge of their operations greatly decreased the possibility of these errors.

Roadway alignment, profile, and cross section information was taken from construction drawings provided by the Illinois Division of Highways and verified by field investigation. All other information concerning roadway characteristics was obtained by field investigations.

● ● ●

B. SELECTION OF HIGHWAY SEGMENTS FOR STUDY

At the beginning of this study there were no published reports indicating the expected frequency and nature of vehicle encroachments on medians of divided highways for any set of conditions. Therefore, knowledge on which to base the selection of appropriate study sites was limited.

It was assumed that vehicle encroachments upon the median might generally be separated into two basic classes: (1) inadvertent encroachments due to a decrease in driver alertness resulting from the comfortable driving conditions on modern divided highways with relatively low traffic volumes and (2) encroachments due to emergency action taken by drivers in attempting to avoid collisions. The probability of the first occurring would appear to be greater on low-volume rural highways, and the probability of the second would appear to be greater on high-volume urban expressways. For this reason an attempt was made to study both extremes in traffic volume.

General characteristics of the chosen highway segments are discussed in the following chapters. Appendix D contains a detailed discussion of these characteristics.

III. FREQUENCY OF ENCROACHMENTS

A. SIGNIFICANCE

Knowledge of the frequency of vehicle encroachments on medians of divided highways is essential to the median designer. Both the decision to design the median as a stopping and recovery space for erratically moving vehicles and the justification for the expense involved in providing such a median must be based upon some knowledge of the extent to which it will be used in this capacity. The more frequent the use of the median as a vehicle stopping and recovery space, the more elaborate and accommodating the median should be.

The frequency of encroachments at any given location also indicates the possible factors causing or influencing encroachments. These possible causes point out to the designer or researcher a basis for attempted corrective measures. Such an approach is more fundamental in that it is aimed at reducing the number of vehicles which leave the pavement rather than merely considering the space and conditions needed to accommodate vehicles that do run off the pavement.

B. PROCEDURE

Because of limitations of time, money, and personnel, only four-lane highways were considered in planning the study of encroachment frequency. The primary concern was the development of relationships between the frequency and/or rate of median encroachments and traffic volume. No attempt was made to obtain the great quantity of data necessary for development of a critical comparison of these relationships for six-lane and eight-lane highways.

The data for this phase of study were obtained from F.A.I. Route 74, from U.S. Route 150 spur at Urbana to the U.S. Route 150 junction at Danville, and a portion of Kingery Expressway, from Calumet Expressway to the Illinois-Indiana state line, Chicago. Both of these highway segments, described in Appendix E, have dual 24-foot roadways, complete control of access, and essentially tangent alignment. The widths and cross sections of the medians are different. F.A.I. Route 74 has a 40-foot median, depressed about 3 feet, whereas the Kingery Expressway median is

18 feet in width and is depressed about 6 inches. However, from the standpoint of factors affecting encroachment frequency, the most significant difference in the design features is roadway delineation. F.A.I. Route 74 has reflective delineators; Kingery Expressway does not. Some roadway delineation is provided by wooden cable-barrier posts in the Kingery Expressway median, but the general level of delineation is undoubtedly lower than on F.A.I. Route 74.

Traffic volumes increased from about 1,700 to 6,000 vehicles per day on F.A.I. Route 74 and from 18,000 to 31,000 vehicles per day on Kingery Expressway during the periods for which encroachment data were compiled. Encroachment and traffic-volume data for the 3-mile Kingery Expressway study section, obtained from the Illinois Division of Highways, were for 4-month periods extending from December 1 through March 31 during the winters of 1957-58, 1958-59, and 1959-60. Encroachment data for the 24.6-mile F.A.I. Route 74 study section were recorded by project personnel during the period from October 4, 1960, through April 6, 1964. During this period 10 traffic counts were made on F.A.I. Route 74. Each count was for a period of one week with traffic volumes recorded in 15-minute intervals. The average daily traffic volumes for F.A.I. Route 74 represent an average of the eastbound and westbound counts at the ends of the 24.6-mile study section. Figure 1 shows the traffic volume record.

C. FINDINGS

The volume and encroachment frequency data for F.A.I. Route 74 and Kingery Expressway are shown in Table 1.

Figures 2 through 5 graphically illustrate the relationships between traffic volume and the recorded vehicle encroachments on the median. The relationship between traffic volume and the frequency of vehicle encroachment upon the median (encroachments per mile of highway per year) is shown by Figures 2 and 4. Figures 3 and 5 indicate the relationship between traffic volume and encroachment rate (encroachments per 100 million vehicle-miles of travel).

The curves in Figures 2 and 3 have been constructed through the weighted averages of the encroachment data points for traffic volumes of approximately 4,200 and 5,800 vehicles per day on F.A.I. Route 74. This minimized the effects of seasonal variations in number of encroachments for periods with approximately equal traffic volumes. The basic character of the relationships, Figures 7 and 8, is not changed by averaging the data points, Figures 2 and 3. Observed seasonal variations in numbers of encroachments are shown in Figure 6 and discussed in Chapter V.

As indicated in Figure 2, the frequency of encroachment increased with traffic volume until an Average Daily Traffic (ADT) volume of about 4,000 vehicles per day was reached. At subsequent higher traffic volumes the frequency of encroachments decreased until a minimum was attained at about 6,000 vehicles per day.

The dashed line in Figure 4 connecting the data points for F.A.I. Route 74 and Kingery Expressway shows the general nature of the change in encroachment frequency expected on F.A.I. Route 74 at volumes greater than 6,000 vehicles per day. It is not an extrapolation of encroachment data under the assumption that the relationship between encroachment frequency and traffic volume is not affected by differences in the design features of these two highways. Previously reported findings indicate that such an assumption is not valid.[6] The superior roadway delineation on F.A.I. Route 74 should result in somewhat lower encroachment frequencies than are represented by this dashed line. Furthermore, the observed frequency of encroachment on Kingery Expressway is probably high because of seasonal influences; all Kingery Expressway data were collected during winter months. Therefore, the dashed line in the interval from 6,000 to 20,000 vehicles per day is only an indication of the general shape and direction of the volume-frequency relationship predicted for F.A.I. Route 74.

The point representing a volume of approximately 18,000 vehicles per day for the winter of 1957-58 does not fall on the curve, because the record of encroachments obtained during this first winter of study on Kingery Expressway was incomplete. Failure to properly co-ordinate field activities with snow storms resulted in the loss of some encroachment evidence. The data point for this period falls below the constructed curve, thus indicating a proper relative position of the portion of the curve representing Kingery Expressway data.

Encroachment rate (Figures 3 and 5) is a function of the slope of the encroachment frequency curve. At a traffic volume of 3,000 to 4,000 vehicles per day the encroachment rate on F.A.I. Route 74 began to decrease rapidly with increasing traffic volume. As the traffic volume approached 6,000 vehicles per day the encroachment rate became relatively constant at a value less than one-third of the original value. The trend of the curve at about 6,000 vehicles per day (Figure 5) suggests a more or less constant encroachment rate, equal to or less than the rate for Kingery Expressway at higher traffic volumes.

D. DISCUSSION

The data graphically presented in

Figures 2 through 5 show a relationship between traffic volume and encroachment rate and frequency, with changes occurring at volumes of approximately 4,000 and 6,000 vehicles per day. The proposed explanation is based on the differences in driving environment associated with changes in traffic volume.

Drivers act more or less independently at low traffic volumes; there is extensive freedom of movement restricted only by physical features of the roadway. Furthermore, modern high-speed highways are designed to relieve the driver of many of the operational decisions necessary on two-lane highways. This environment leads to inattentiveness and reduced alertness which increase the probability of an unintentional median encroachment. Drivers operating in low density traffic streams can be considered isolated units; therefore, the probability of a median encroachment is constant for each vehicle and independent of the behavior of other vehicles.

Another important consideration is the reduced roadway delineation at low traffic volumes. Vehicles, in a sense, delineate the roadway and provide a reference point for lateral positioning of the vehicles further back in the traffic stream. In the absence of other vehicles the driver must orient his vehicle with physical features of the roadway which may or may not provide adequate delineation. If, however, other vehicles are present the driver has a tendency to caravan, consciously or subconsciously following the vehicle ahead.

As traffic volume increases, driver-vehicle behavior is influenced to a greater and greater extent by the presence of other vehicles. The decreased spacing between vehicles apparently increases driver alertness and roadway delineation with a resulting reduced probability of an inadvertent encroachment. At the same time the probability of encroachment due to evasive action or actual physical contact between vehicles seems to increase.

Considering Figures 2 and 4, it may be reasoned that in the interval between 0 and 2,000 vehicles per day (extrapolated), the driver is operating independently of other vehicles and the probability of a median encroachment is constant for each unit. Thus, the number of encroachments is primarily dependent on the number of vehicles subject to the chance of encroachment. A linear relationship therefore exists between encroachment frequency and traffic volume. As traffic volume increases above 2,000 vehicles per day the effect of improved roadway delineation and driver alertness is illustrated by the decreasing slope of the volume-frequency relationship. The probability of an unintentional median encroachment is reduced and the frequency increases at a decreasing rate.

At about 4,000 vehicles per day the frequency of encroachment begins to decrease with increasing traffic volume. The effect of greater numbers of vehicles subject to the chance of encroachment is more than offset by the gradual improvement in roadway delineation and the rising level of driver alertness.

As traffic volume increases, however, so does the friction and conflict between vehicles. The driver must devote a larger share of his attention to the maneuvers and positioning of other vehicles. Friction and conflict between vehicles is reflected in the more severe encroachments resulting from evasive action and/or physical contact between vehicles. The average angle of encroachment increases in the interval from 4,000 to 6,000 vehicles per day (Figure 9). The percentage of encroaching vehicles that cross the median also becomes larger (Figure 10).

Encroachments are not only more severe, but also more varied. This is illustrated by an increasing scatter of data points in the interval from 4,000 to 6,000 vehicles per day as shown in Figures 9 and 11. The greater variety in types of encroachments is a result of changes in the relative importance of many volume related factors which affect the frequency and nature of encroachments. Most important among these factors is the increasing contrast between the types of driving environment found at different periods of the day. Inadvertent encroachments, associated with low traffic volumes, are represented because the conditions that produce them are still prevalent during low volume periods. Nevertheless, new reasons for inadvertent encroachments become evident during high volume periods of the day. The driver must often devote more attention to the relative position of nearby vehicles than to the alignment of the roadway and the lateral placement of his own vehicle. The driving task steadily becomes more complex as the traffic volume increases.

The trend of the volume-frequency curve (Figure 4) in the interval from 5,000 to 6,000 vehicles per day reflects the growing complexity of the driving task and the resulting increase in encroachments that can be expected at higher traffic volumes. The dashed portion of the curve, in the interval from about 6,000 to 20,000 vehicles per day, shows a somewhat more rapid encroachment-frequency increase than is to be expected on F.A.I. Route 74,* but it is indicative of the anticipated linear increase.

All available evidence points toward a linear increase in encroachment frequency with higher traffic volumes. This can best be illustrated in connection with encroachment rate (Figure 5). A linear increase

*See preceding discussion of the seasonal influence on Kingery Expressway data.

in encroachment frequency is equivalent to a constant encroachment rate. All the encroachment rates in Table 2 are of the same general magnitude even though a wide range of traffic volumes are represented. This suggests a more or less constant encroachment rate and a linear increase in encroachment frequency at higher traffic volumes.

The encroachment rates for Calumet and Edens Expressways were calculated from data collected in 1960. Evergreen trees had been planted in the medians of both expressways.[4] The trees are assumed to have provided slightly better roadway delineation than the reflective delineators on F.A.I. Route 74 and therefore, the given encroachment rates for Calumet and Edens Expressways should be slightly lower than those for F.A.I. Route 74 at equivalent traffic volumes. The encroachment rate for higher traffic volumes on F.A.I. Route 74 is expected to be somewhere between the Kingery Expressway rate (Figure 5) and the given rates for Calumet and Edens Expressways, i.e., between 60 and 120 encroachments per 100 million vehicle-miles of travel.

Encroachment rates for the Santa Ana and Nimitz Freeways were calculated from the number of cable-chain-link fence barrier repairs reported by Moskowitz and Schaefer in connection with the study of median barrier performance on California Freeways.[5] It is doubtful that many encroaching vehicles were able to recover within the 6-foot half-width of the curbed medians on these freeways without damaging the barrier.

Edens Expressway and the Santa Ana and Nimitz Freeways are six-lane facilities and therefore cannot be expected to have the same traffic stream characteristics as four-lane F.A.I. Route 74 and Kingery Expressway. However, these differences in traffic stream characteristics do not appear to significantly affect the encroachment rate under the conditions of reduced vehicle headway (time interval between vehicles) associated with high traffic volumes. The average vehicle headway below which the encroachment rate is apparently no longer affected by increased traffic volume is about 15 seconds for F.A.I. Route 74 (Figure 14, as explained in Appendix E). The gap equivalent to this average headway can serve as a basis for a rough estimate of the volume above which the encroachment rate may be expected to remain relatively constant.

This gap is about one-quarter mile, based on the observed 50th percentile speed of 62 mph at an ADT volume of 6,000 vehicles per day on the F.A.I. Route 74. The ADT volume producing an average headway equivalent to a one-quarter-mile gap is, therefore, the volume above which the encroachment rate appears to become relatively constant. In the absence of more complete data, this gap can serve as the basis for a rough estimate of the minimum ADT volume at which the encroachment rate may be expected to become relatively constant on a multi-lane divided highway with complete control of access. A comparison of the relatively constant encroachment rates for highways carrying equal or greater ADT volumes should indicate the relative safety provided by different design features.

The previously reported experiment with evergreen trees on the medians of Calumet and Edens Expressways was based on such a comparison of encroachment rates.[4] Encroachment data necessary for such comparisons will be more readily available in the form of median barrier repair records as growing traffic volumes on present multi-lane highways exceed the minimum volumes suggested as warrants for the installation of median barriers.[6]

● ● ●

SUPPORTING DATA

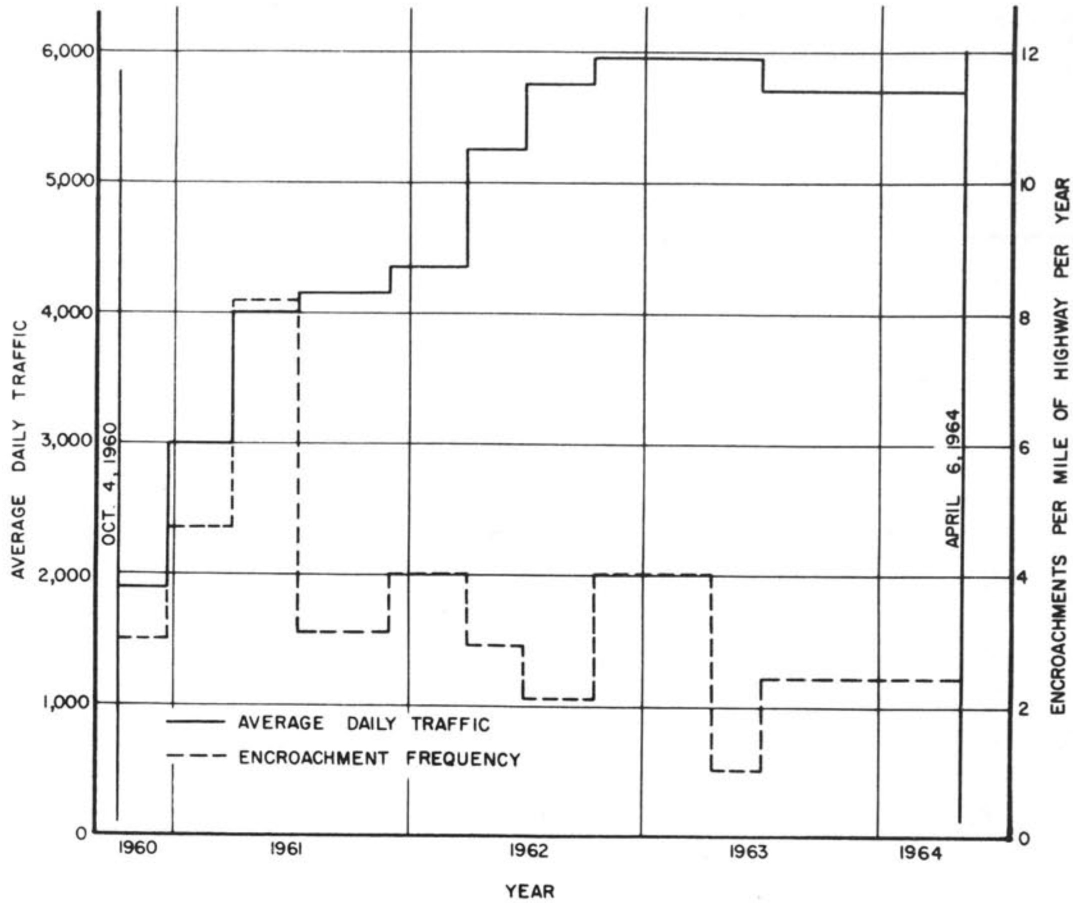


FIGURE 1. COMPARISON OF VARIATIONS IN TRAFFIC VOLUME AND ENCROACHMENT FREQUENCY FOR F.A.I. ROUTE 74

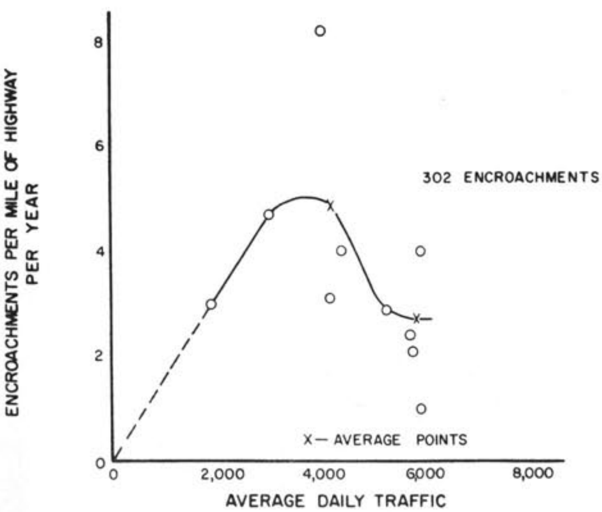


FIGURE 2. ENCROACHMENT FREQUENCY FOR F.A.I. ROUTE 74

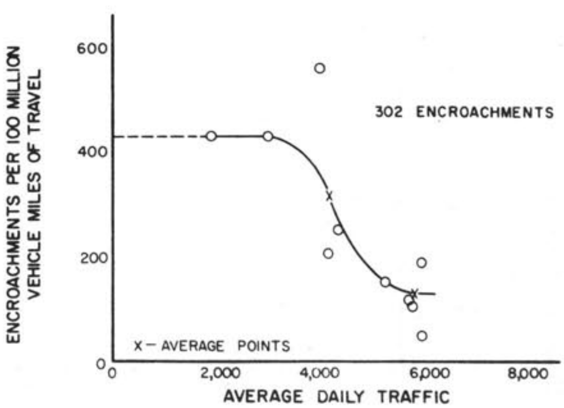


FIGURE 3. ENCROACHMENT RATE FOR F.A.I. ROUTE 74

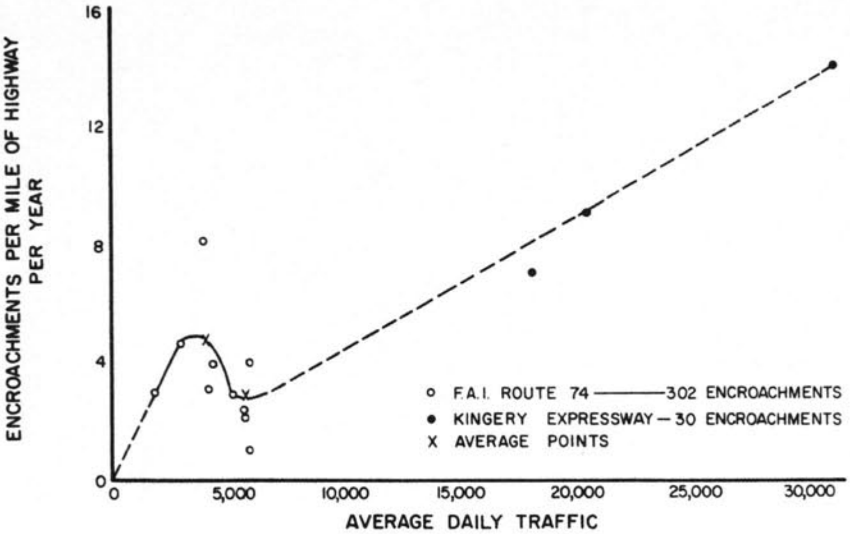


FIGURE 4. ENCROACHMENT FREQUENCY FOR F.A.I. ROUTE 74 AND KINGERY EXPRESSWAY

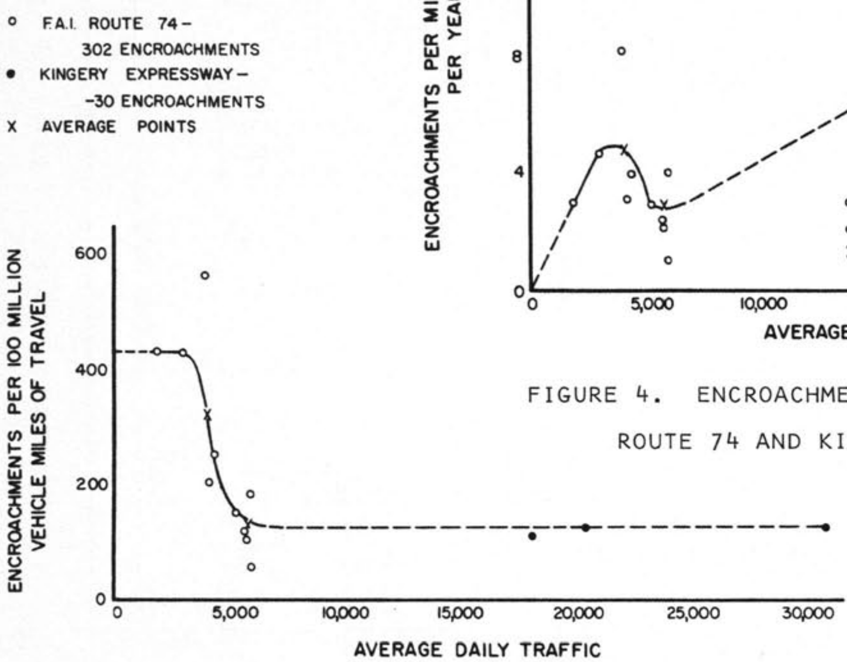


FIGURE 5. ENCROACHMENT RATE FOR F.A.I. ROUTE 74 AND KINGERY EXPRESSWAY

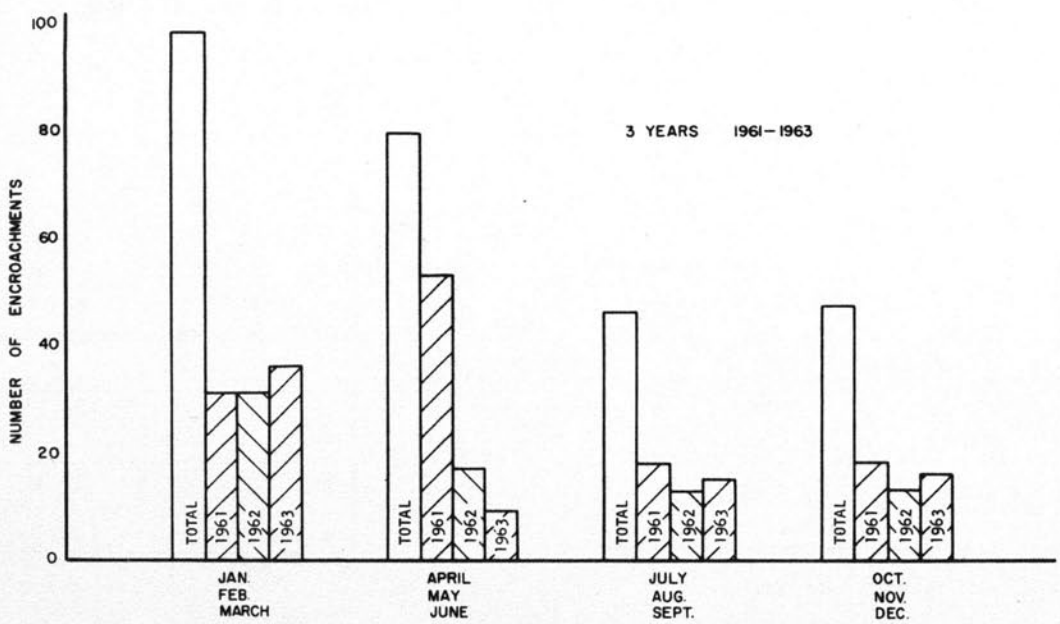


FIGURE 6. SEASONAL VARIATION IN NUMBER OF VEHICLE ENCROACHMENTS ON THE MEDIAN OF F.A.I. ROUTE 74

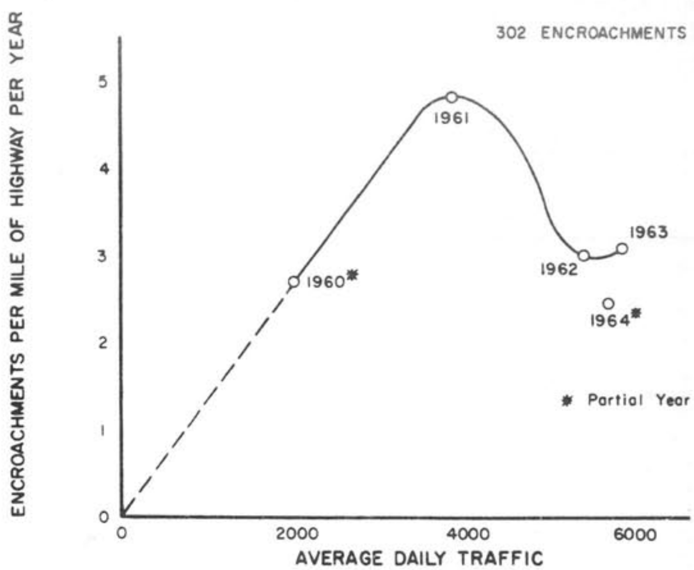


FIGURE 7. YEARLY ENCROACHMENT FREQUENCY FOR F.A.I. ROUTE 74

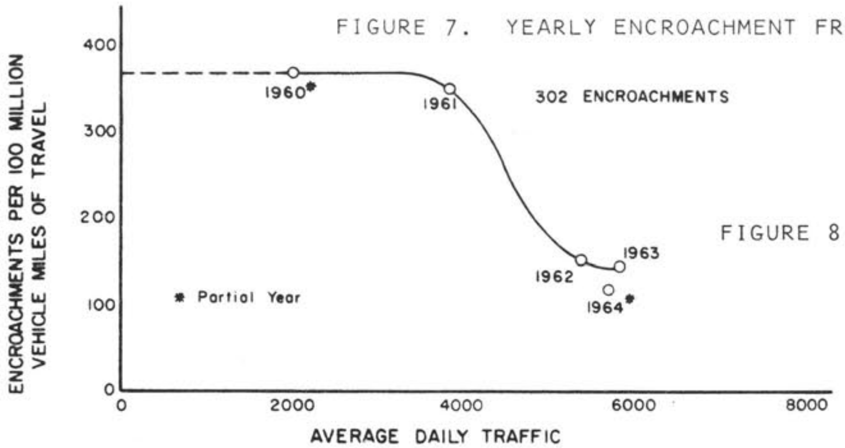


FIGURE 8. YEARLY ENCROACHMENT RATE FOR F.A.I. ROUTE 74

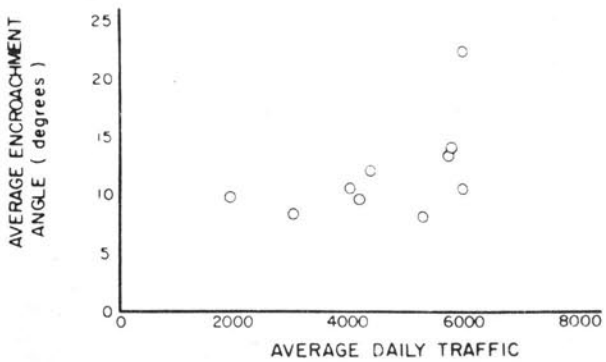


FIGURE 9. RELATIONSHIP BETWEEN TRAFFIC VOLUME AND ANGLE OF ENCROACHMENT FOR F.A.I. ROUTE 74

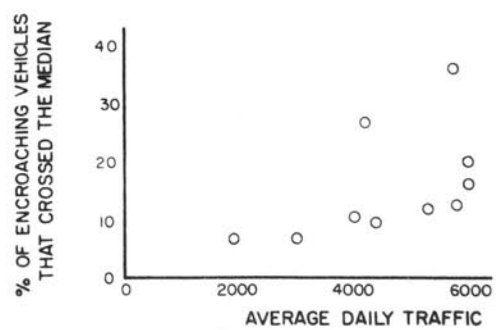


FIGURE 10. RELATIONSHIP BETWEEN TRAFFIC VOLUME AND PER CENT OF ENCROACHING VEHICLES THAT CROSSED THE MEDIAN OF F.A.I. ROUTE 74

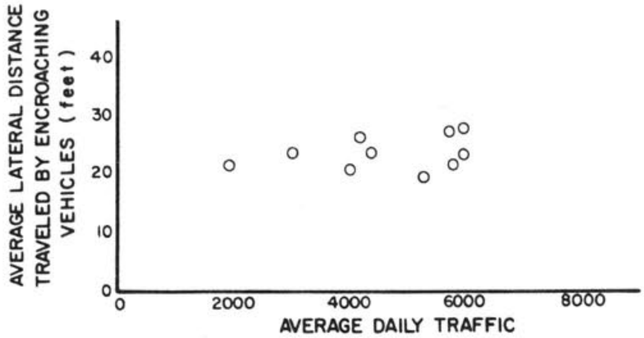


FIGURE 11. RELATIONSHIP BETWEEN TRAFFIC VOLUME AND AVERAGE MAXIMUM LATERAL MOVEMENT OF ENCROACHING VEHICLES FOR F.A.I. ROUTE 74

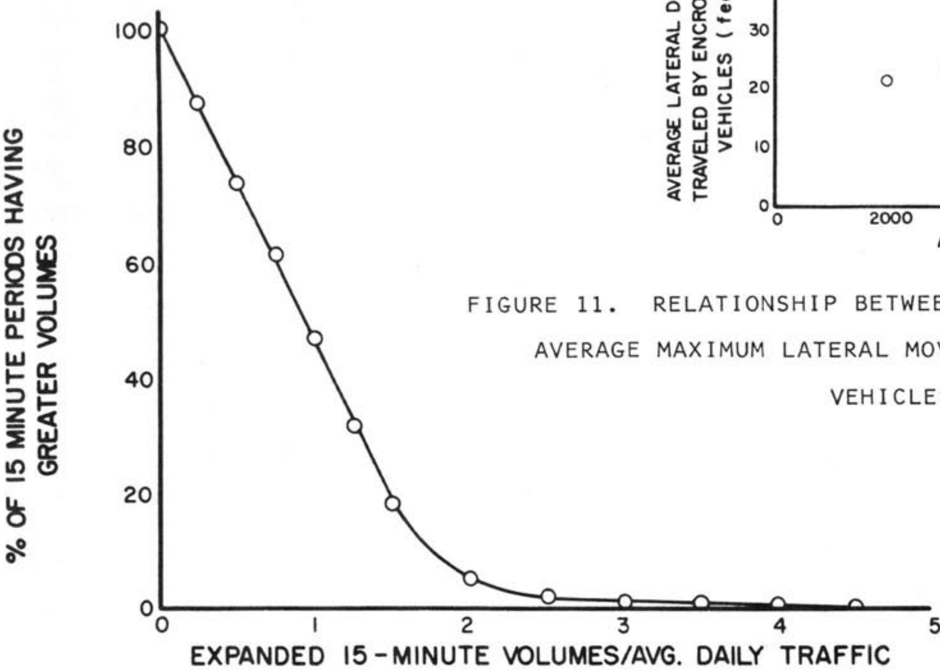


FIGURE 12. OBSERVED DISTRIBUTION OF INSTANTANEOUS VOLUMES ON F.A.I. ROUTE 74

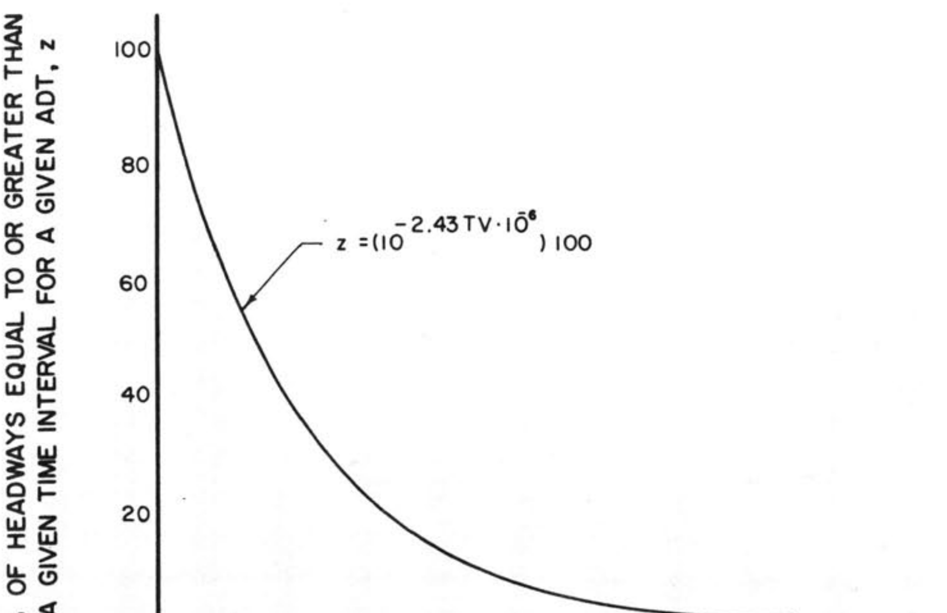


FIGURE 13. AVERAGE DISTRIBUTION OF HEADWAYS ON F.A.I. ROUTE 74

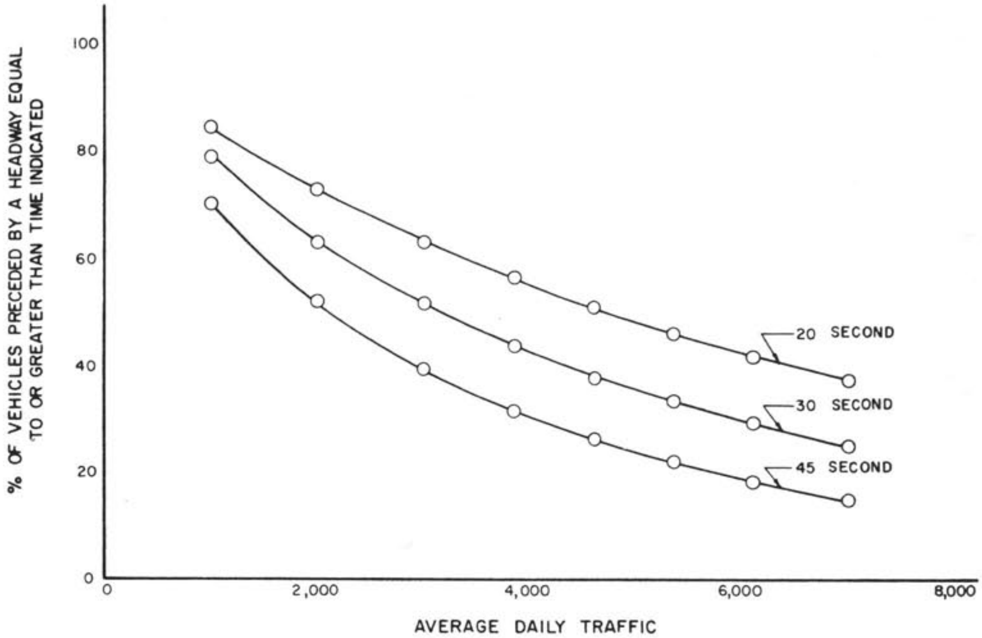


FIGURE 14. CALCULATED DISTRIBUTION OF HEADWAYS ON F.A.I. ROUTE 74

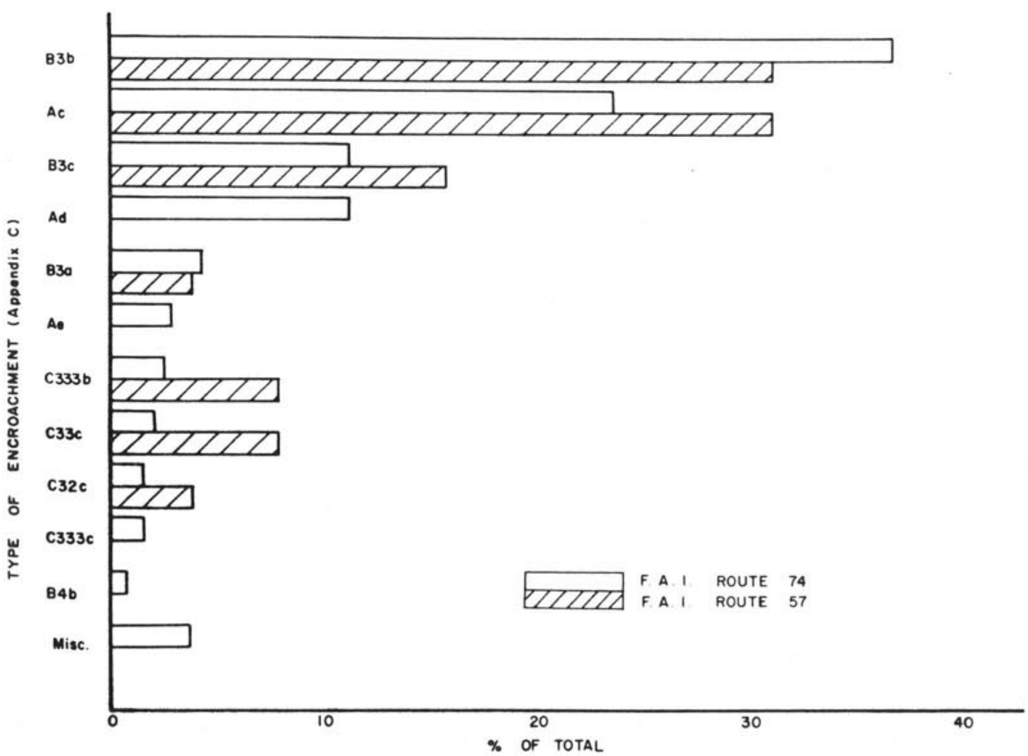


FIGURE 15. RELATIVE FREQUENCY OF OCCURRENCE OF ENCROACHMENT TYPES FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74

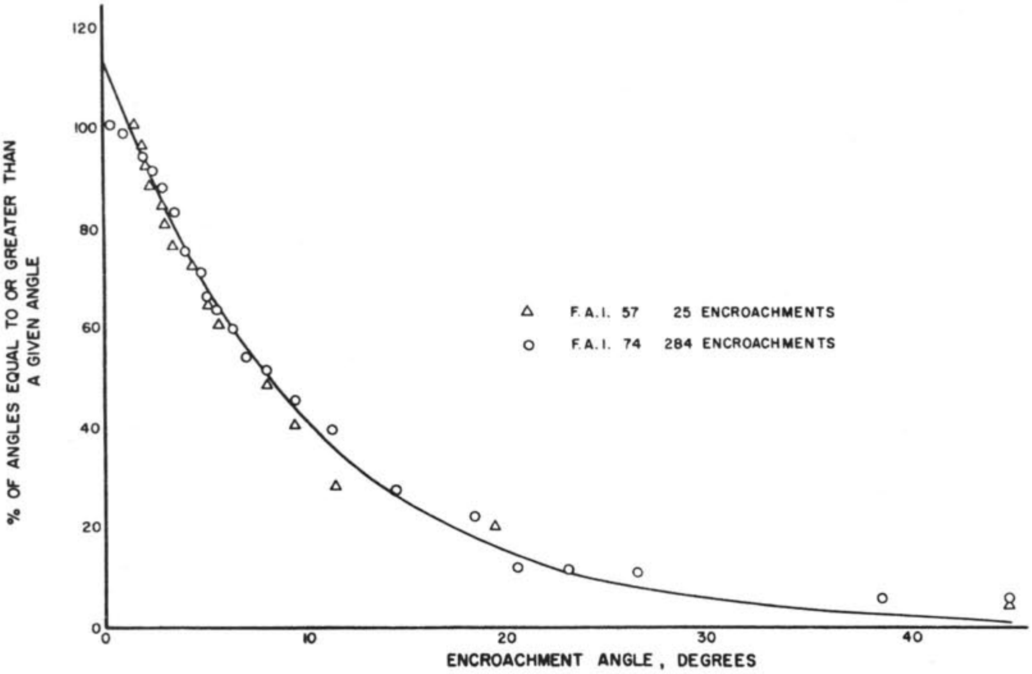


FIGURE 16. DISTRIBUTION OF ENCROACHMENT ANGLES FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74

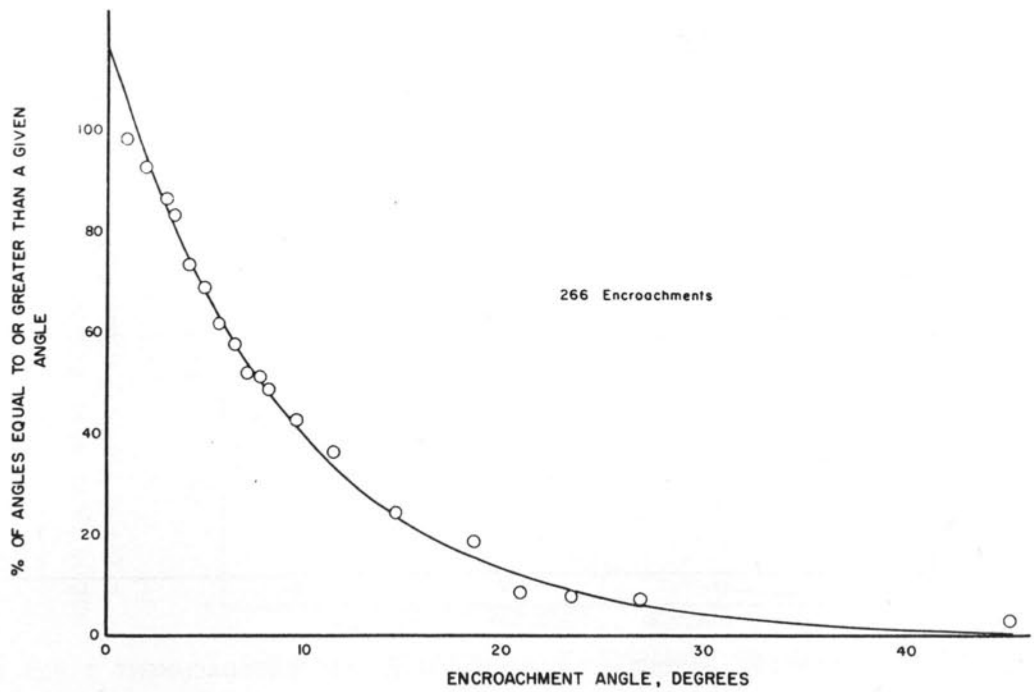


FIGURE 17. DISTRIBUTION OF ENCROACHMENT ANGLES FOR F.A.I. ROUTE 74

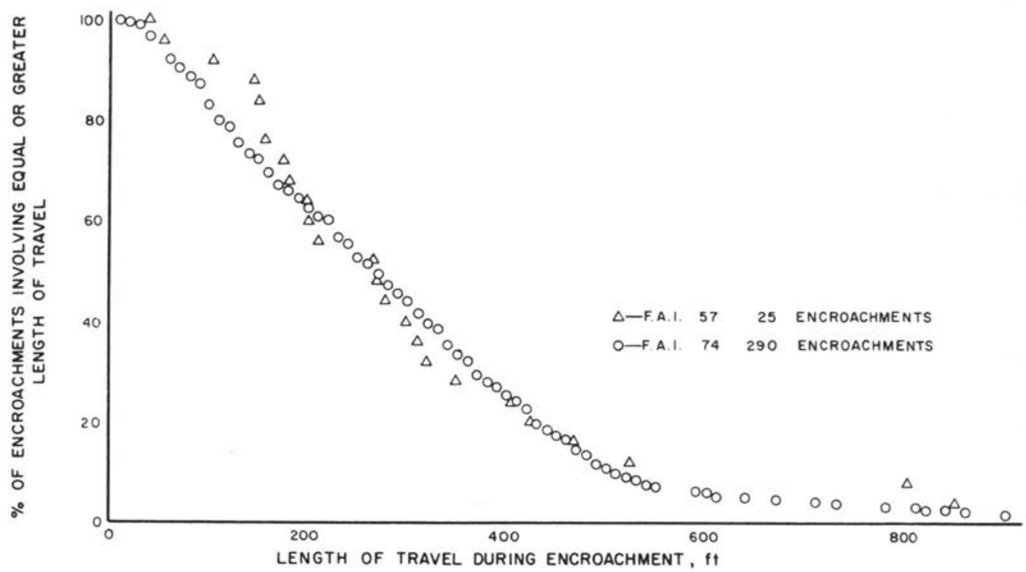


FIGURE 18. DISTRIBUTION OF LENGTHS OF VEHICLE TRAVEL DURING ENCROACHMENT FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74

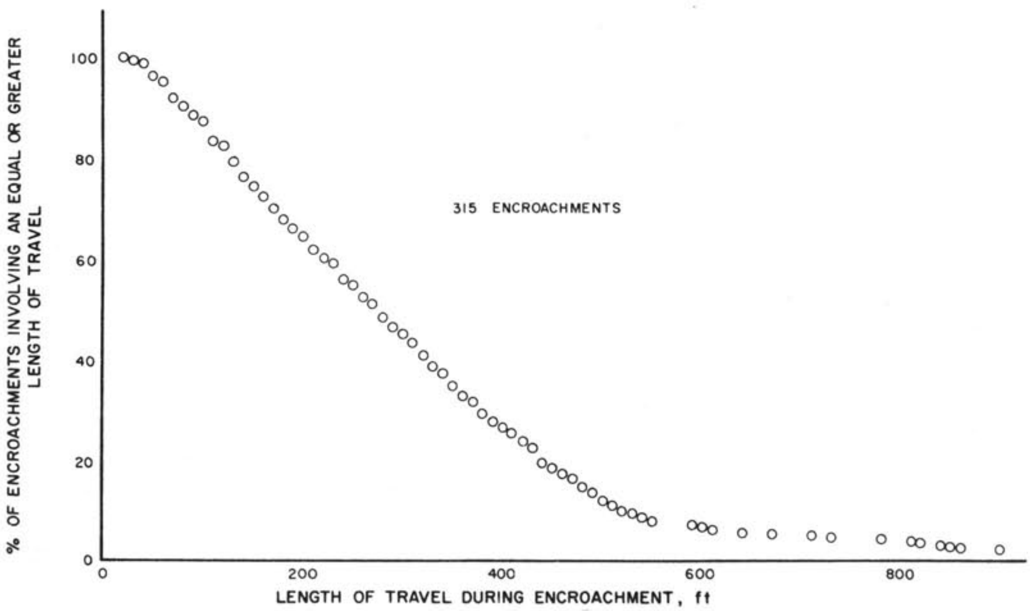


FIGURE 19. DISTRIBUTION OF LENGTHS OF VEHICLE TRAVEL DURING ENCROACHMENT FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74, COMBINED

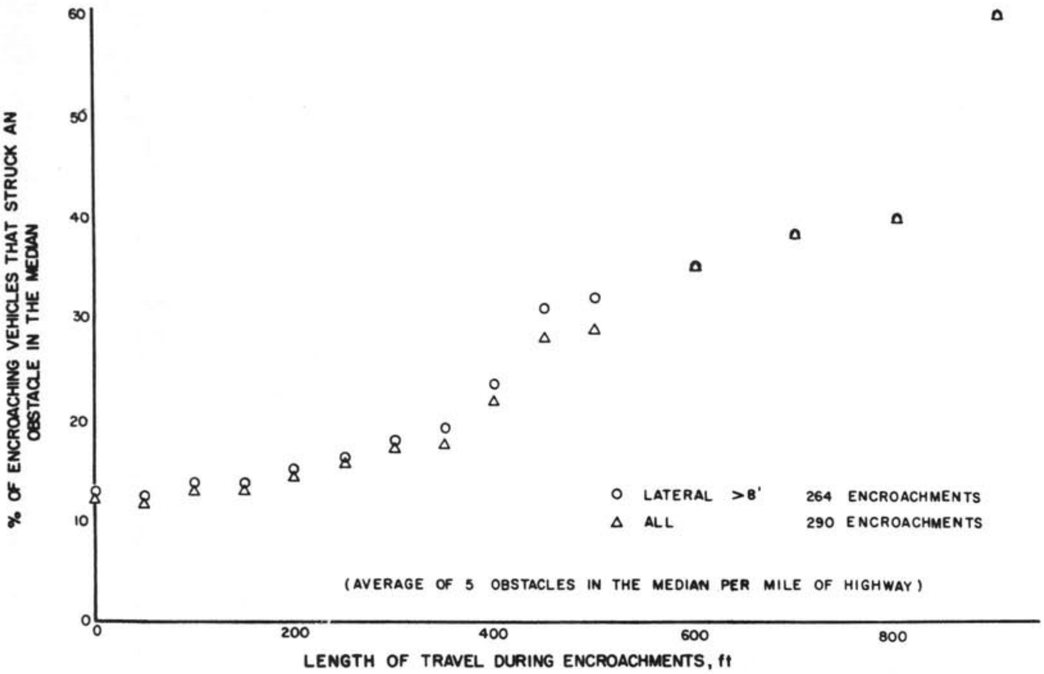


FIGURE 20. FREQUENCY OF VEHICLE COLLISION WITH OBSTACLES AS RELATED TO LENGTH OF TRAVEL DURING ENCROACHMENT FOR F.A.I. ROUTE 74

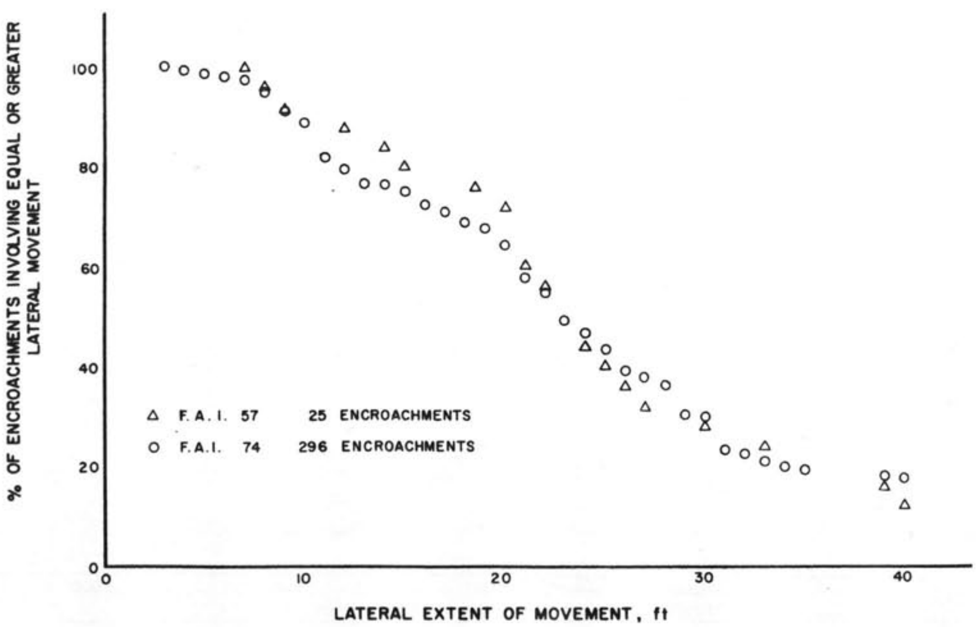


FIGURE 21. DISTRIBUTION OF LATERAL MOVEMENTS OF VEHICLES DURING ENCROACHMENTS FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74

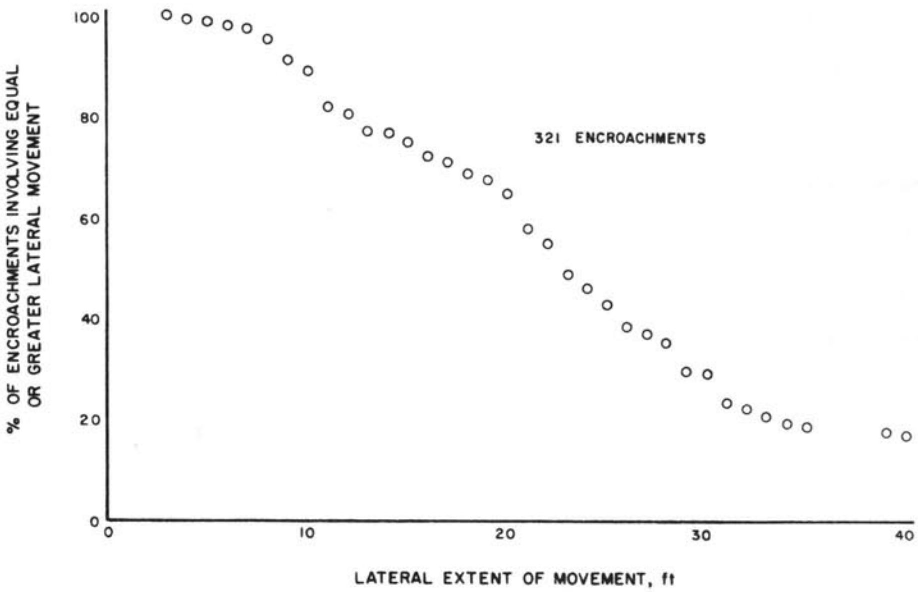


FIGURE 22. DISTRIBUTION OF LATERAL MOVEMENTS OF VEHICLES DURING ENCROACHMENTS FOR F.A.I. ROUTE 57 AND F.A.I. ROUTE 74, COMBINED.

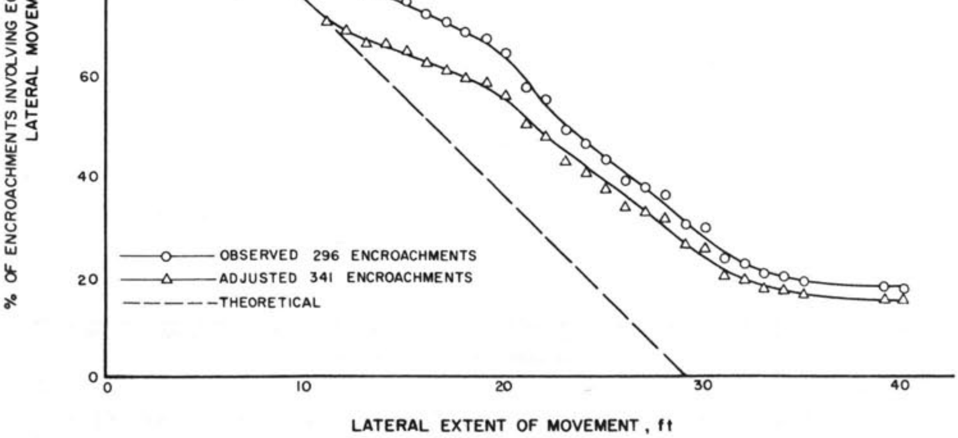


FIGURE 23. DISTRIBUTION OF LATERAL DISTANCES FOR F.A.I. ROUTE 74

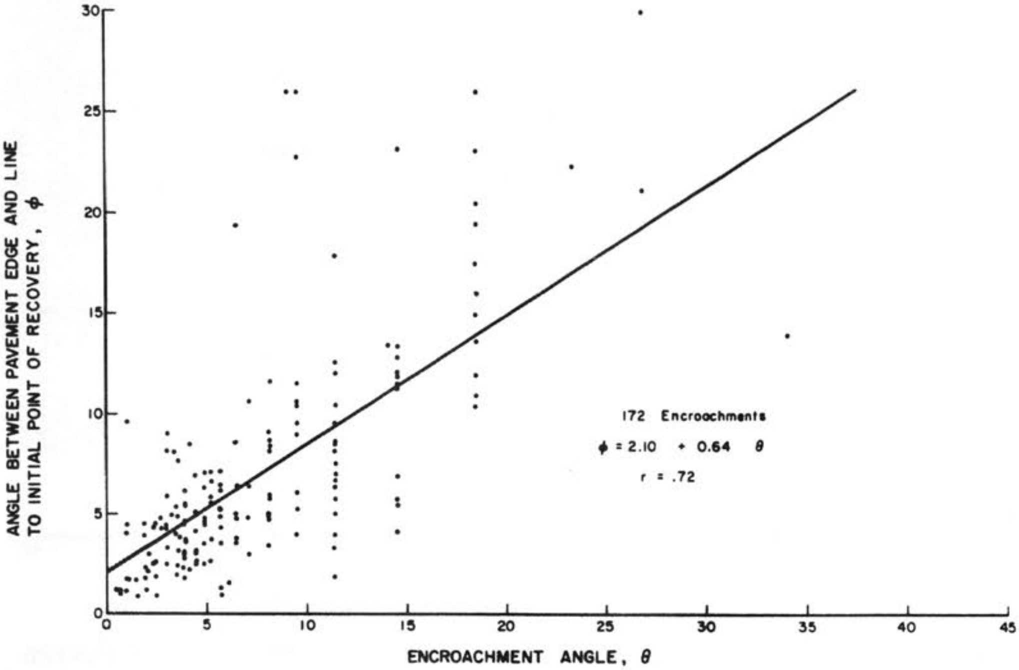


FIGURE 24. RELATIONSHIP BETWEEN ENCROACHMENT ANGLE AND INITIAL POINT OF RECOVERY FOR F.A.I. ROUTE 74

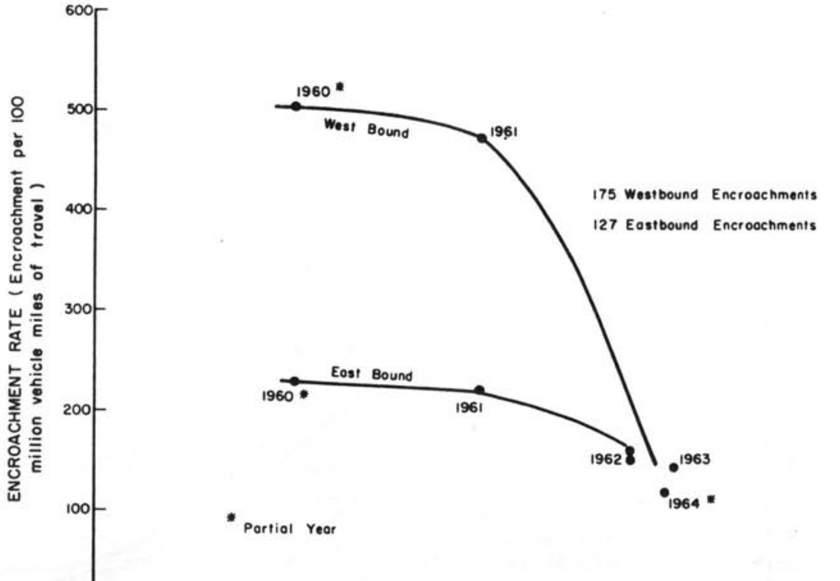


FIGURE 25. YEARLY ENCROACHMENT RATES BY DIRECTION OF TRAVEL FOR F.A.I. ROUTE 74

FIGURE 26. WESTBOUND ENTRANCE RAMP TO F.A.I. ROUTE 74 NEAR DANVILLE, ILLINOIS

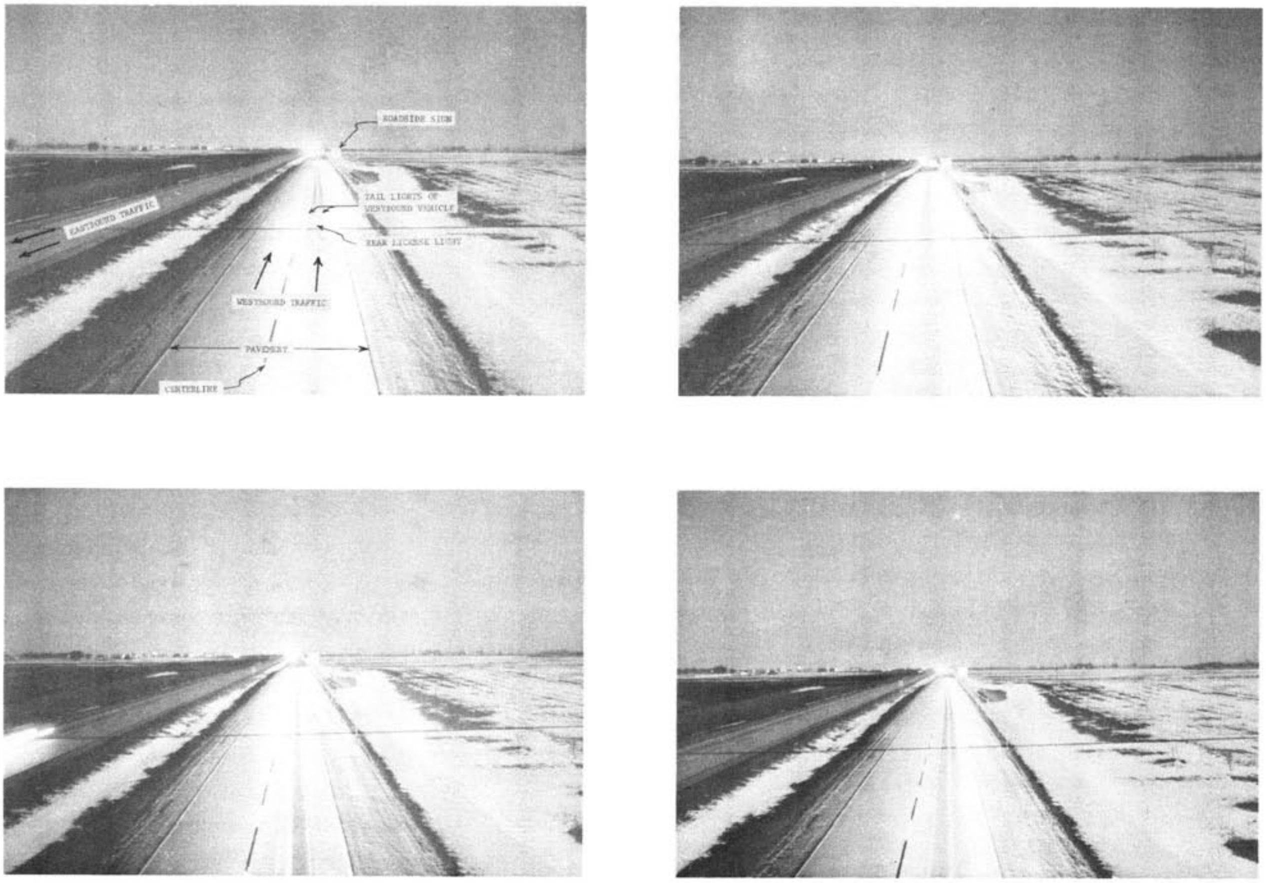


FIGURE 27. TIME EXPOSURE OF TAIL LIGHTS

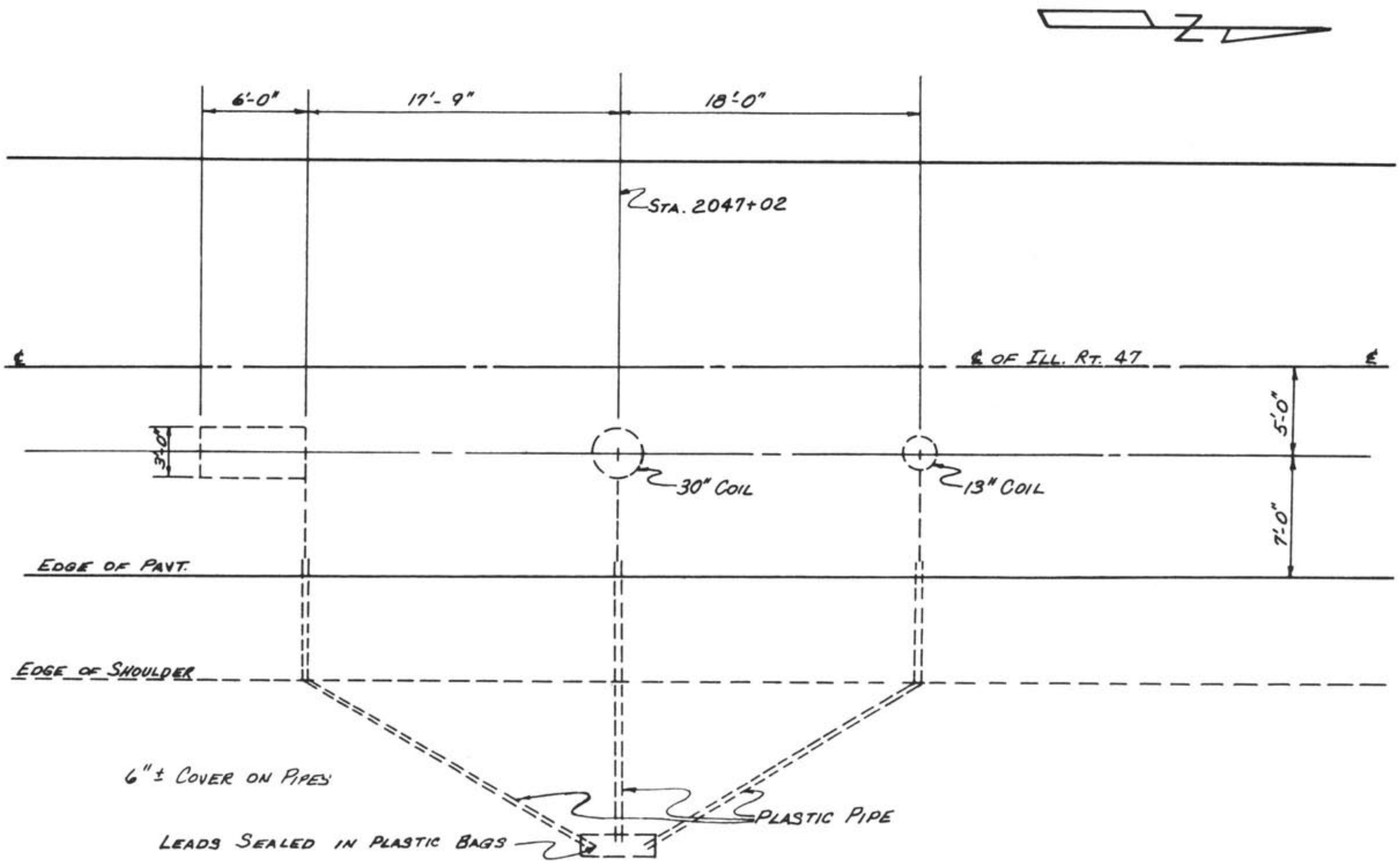


FIGURE A1. TEST COIL INSTALLATION

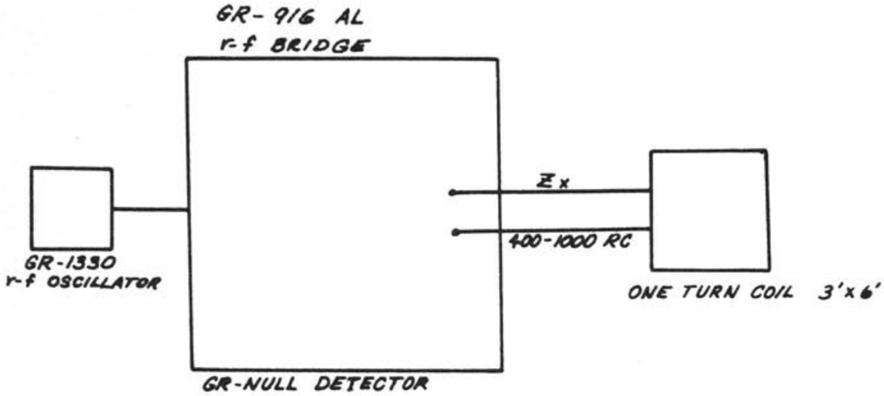


FIGURE A2. TEST COIL DIAGRAM

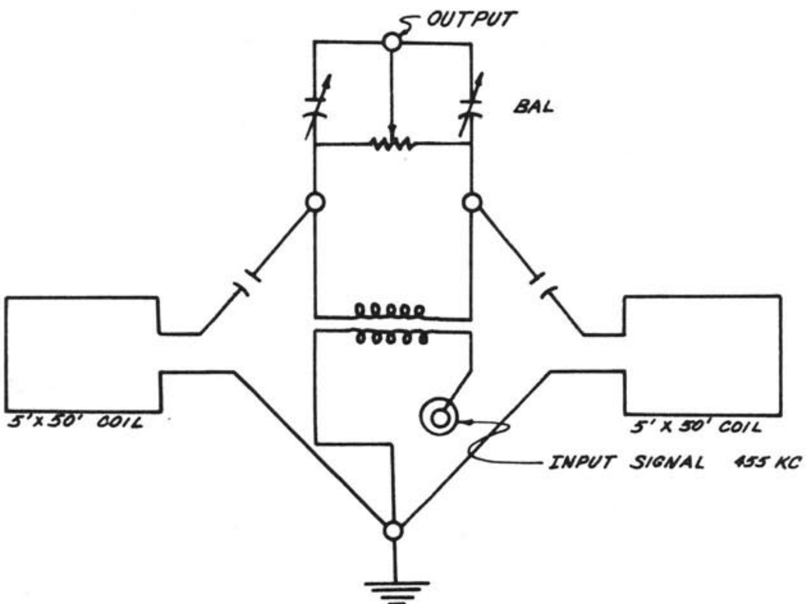


FIGURE A3. TEST COIL DIAGRAM

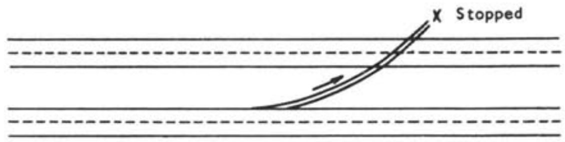


FIGURE C1. AN Ae ENCROACHMENT

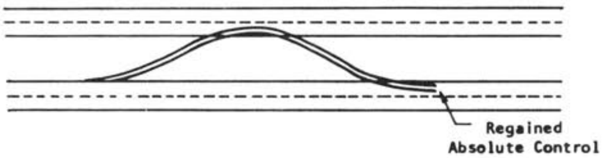


FIGURE C2. A B4b ENCROACHMENT

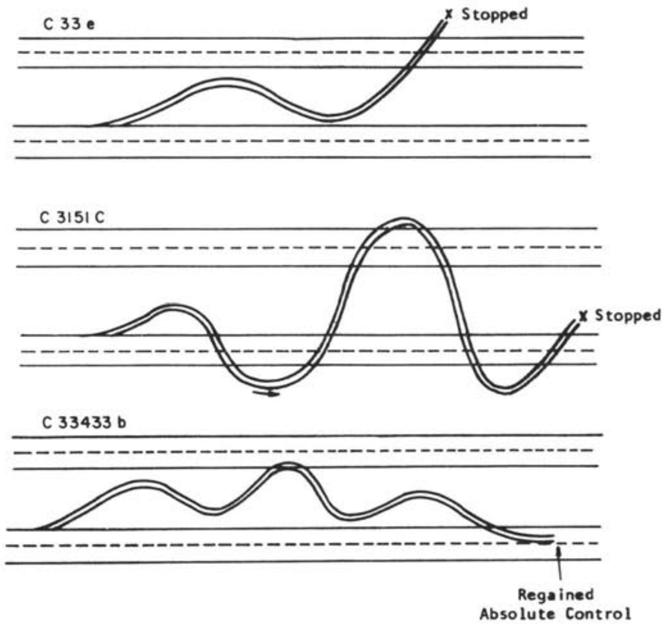


FIGURE C3. C33e, C3151c, C33433b ENCROACHMENTS

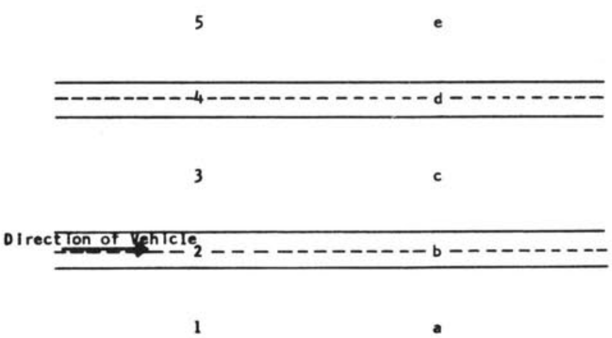


FIGURE C4. CODE OF ZONES

U.S. Route 66

F.A.I. Route 74

FIGURE D1. MEDIAN OBSTACLES AND ENCROACHMENTS

18-inch depression of median ditch invert at culvert openings on U.S. Route 66 south of McLean and on recently constructed F.A.I. Route 74 east of Urbana (earth berm in median in background of both photographs).

U.S. Route 66

F.A.I. Route 74

FIGURE D2. MEDIAN OBSTACLES AND ENCROACHMENTS

Headwalls on culverts open to the median on U.S. Route 66 north of Lawndale and on F.A.I. Route 74 east of Urbana (headwall at left shows damage from truck collision).

FIGURE D3. MEDIAN OBSTACLES AND ENCROACHMENTS

Culvert headwall in median of U.S. Route 66 north of U.S. Route 52 interchange.

FIGURE D4. MEDIAN OBSTACLES AND ENCROACHMENTS

Paved median crossover on U.S. Route 66 south of Chenoa and tracks made by encroaching vehicle.

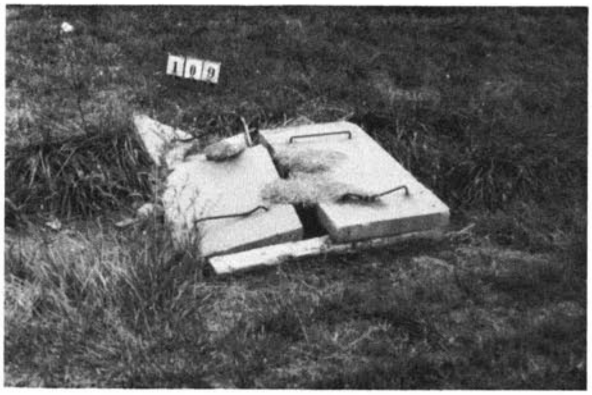


FIGURE D5. MEDIAN OBSTACLES AND ENCROACHMENTS

Drainage inlet with concrete cover one foot higher than median ditch invert on U.S. Route 66 south of Chenoa.

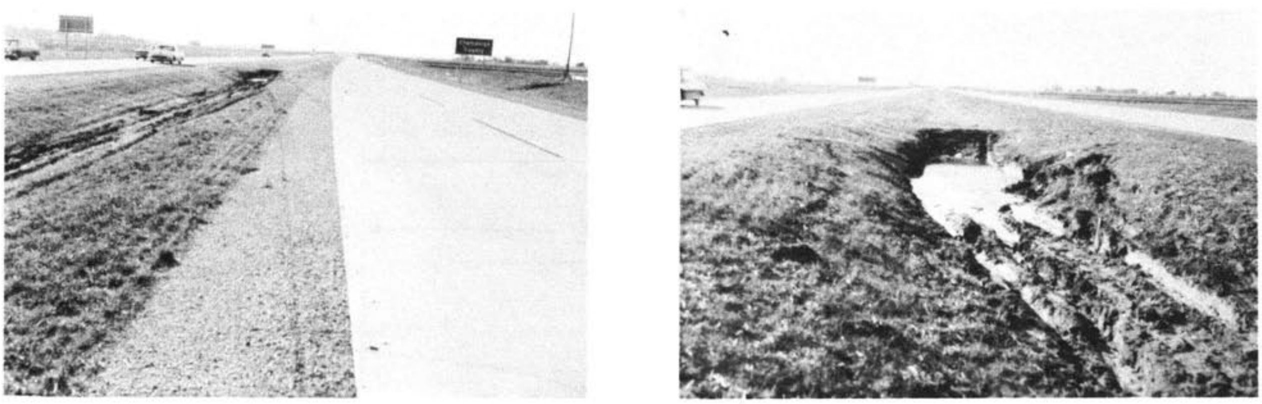


FIGURE D6. MEDIAN OBSTACLES AND ENCROACHMENTS

General view (left) and close-up (right) of tracks made by encroaching vehicle that passed between two culvert headwalls and collided with earth berm in F.A.I. Route 74 median.

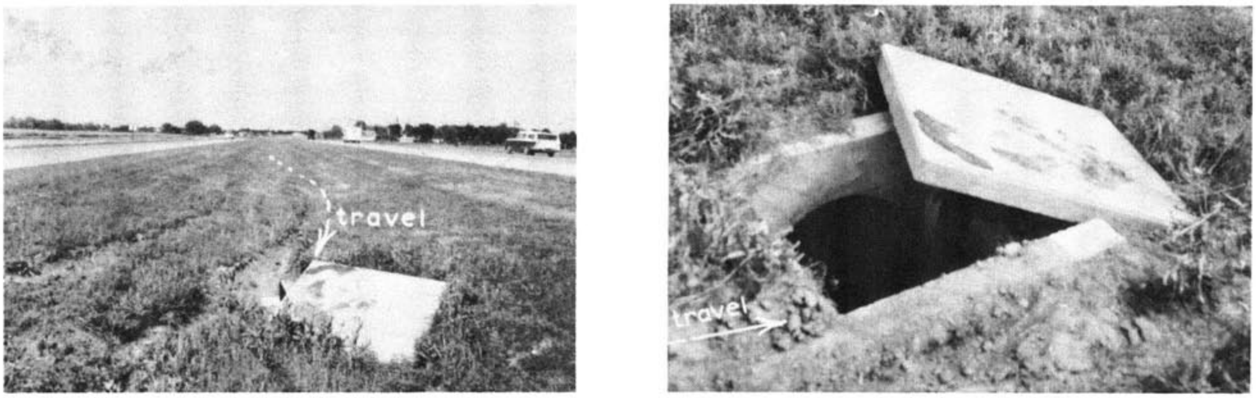


FIGURE D7. MEDIAN OBSTACLES AND ENCROACHMENTS

General view (left) and close-up (right) of results of collosion of encroaching vehicle with 800 pound concrete drainage inlet cover in U.S. Route 66 median east of Rolla, Missouri.

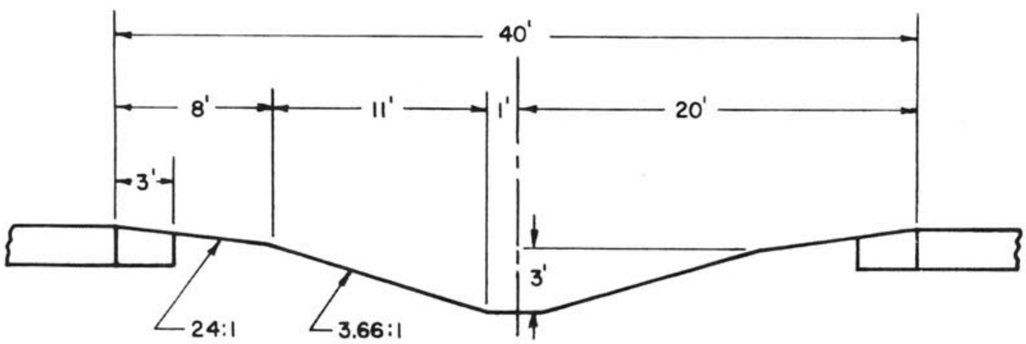


FIGURE D8. TYPICAL MEDIAN CROSS SECTION FOR F.A.I. ROUTE 74

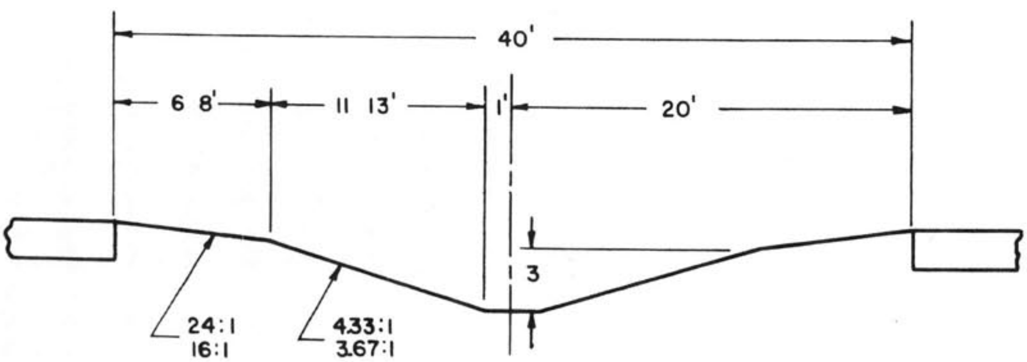


FIGURE D9. TYPICAL MEDIAN CROSS SECTION FOR U.S. ROUTE 66

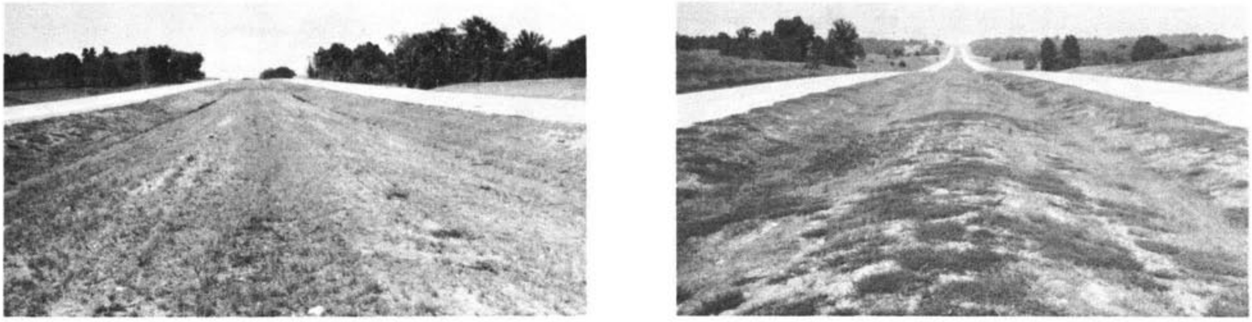


FIGURE D10. F.A.I. ROUTE 57 MEDIAN

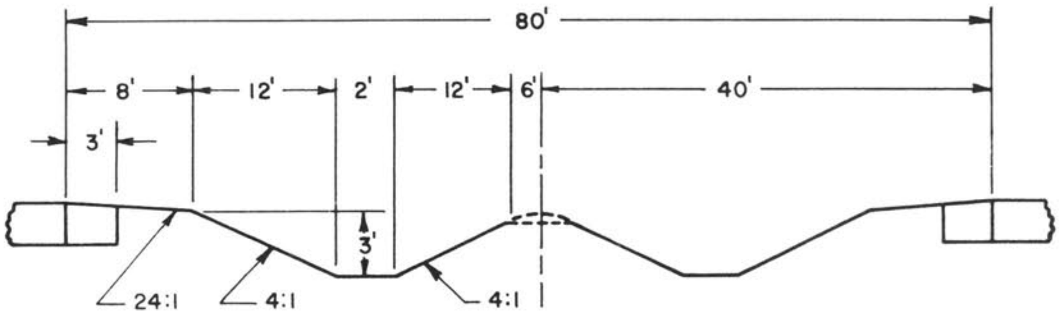


FIGURE D11. TYPICAL MEDIAN CROSS SECTION FOR F.A.I. ROUTE 57

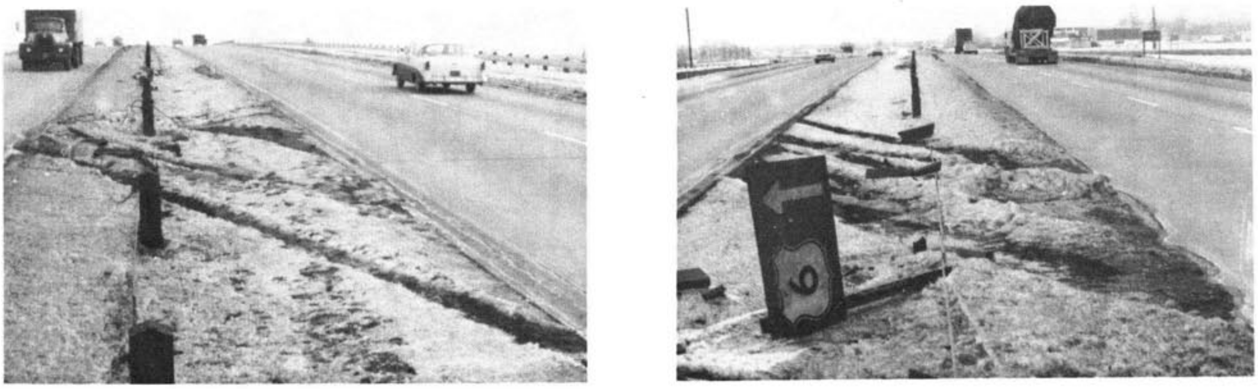


FIGURE D12. KINGERY EXPRESSWAY MEDIAN

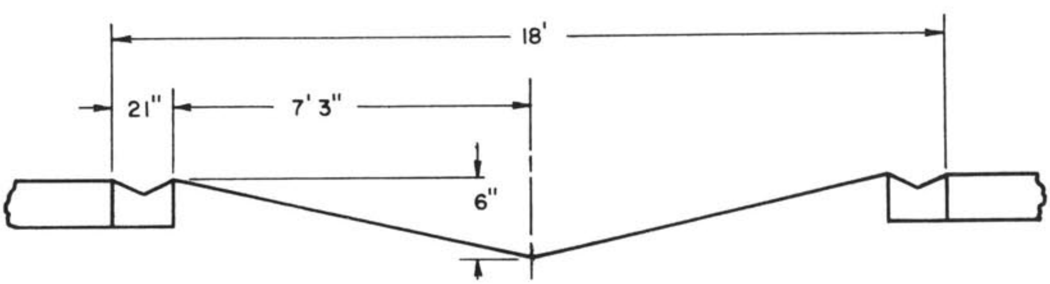
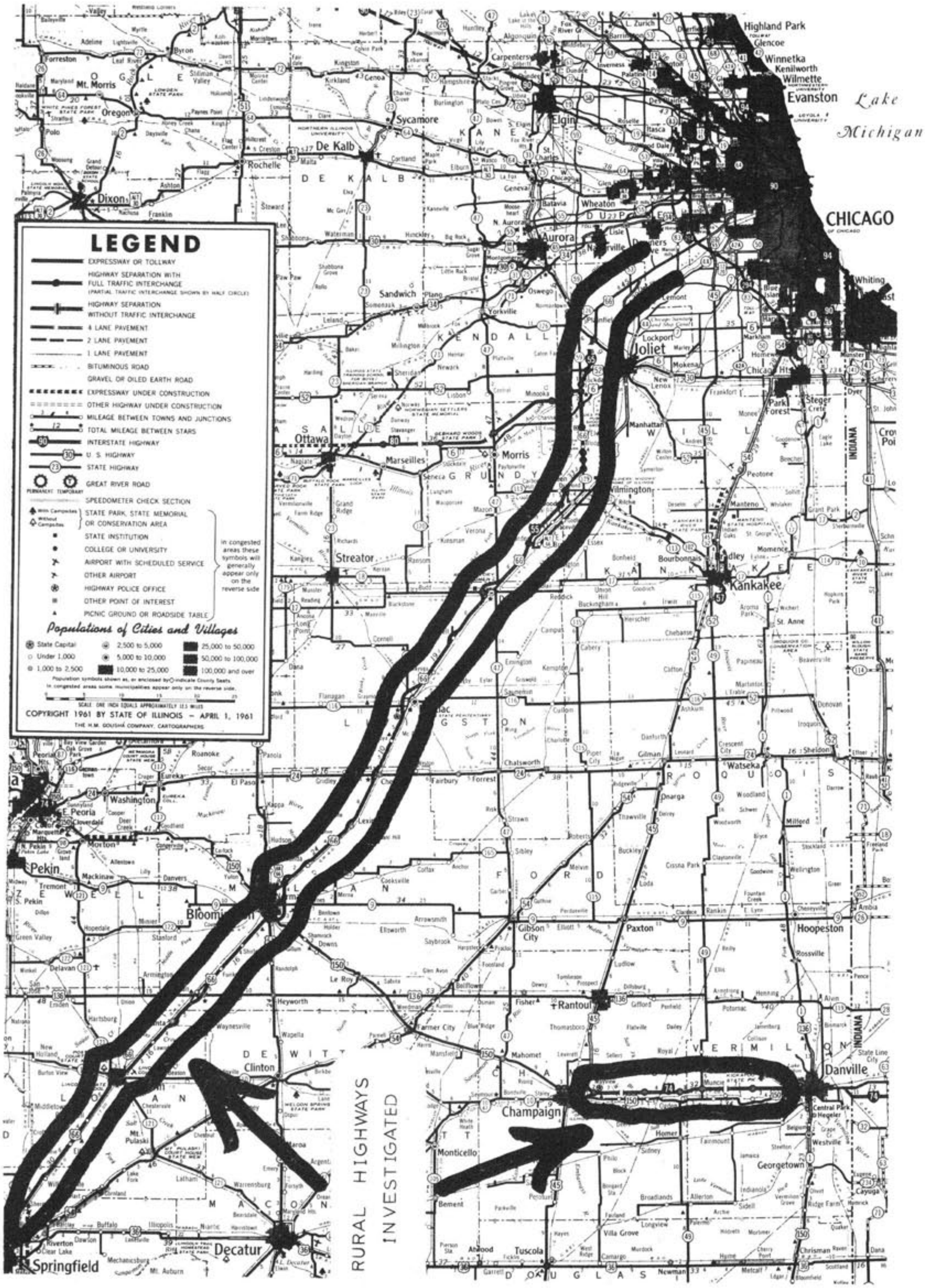
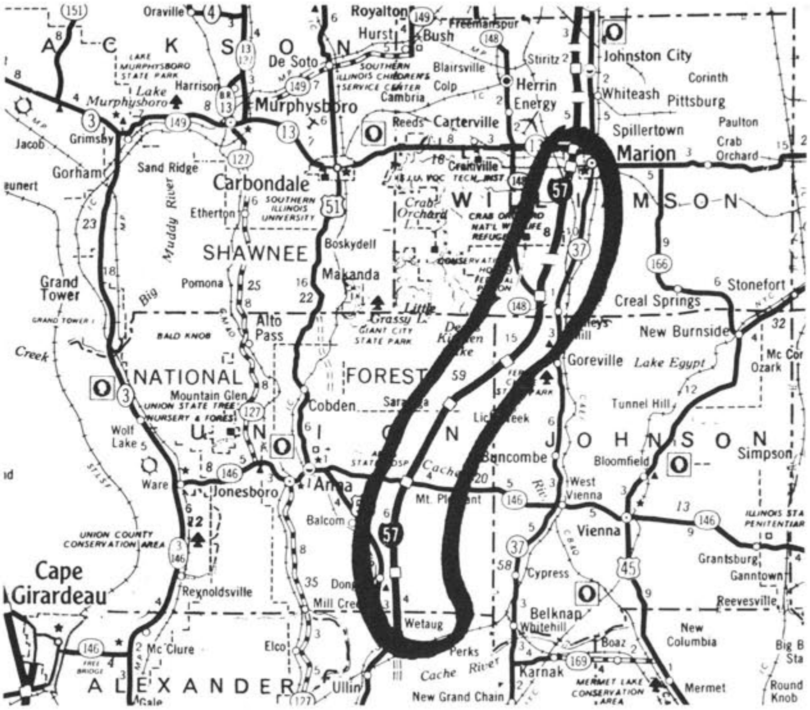


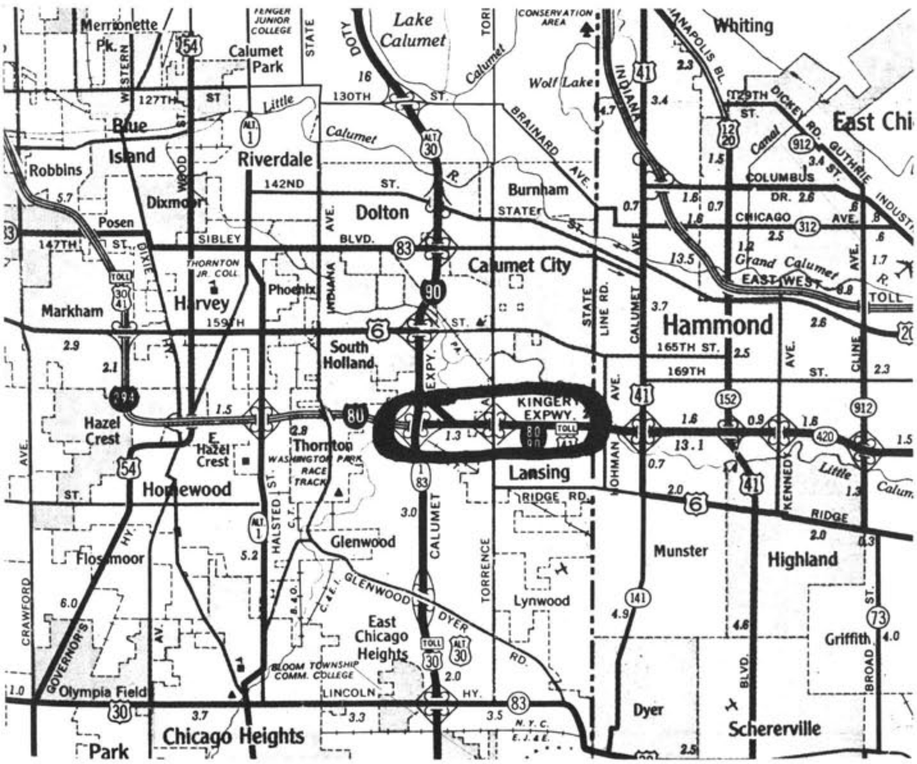
FIGURE D13. TYPICAL MEDIAN CROSS SECTION FOR KINGERY EXPRESSWAY



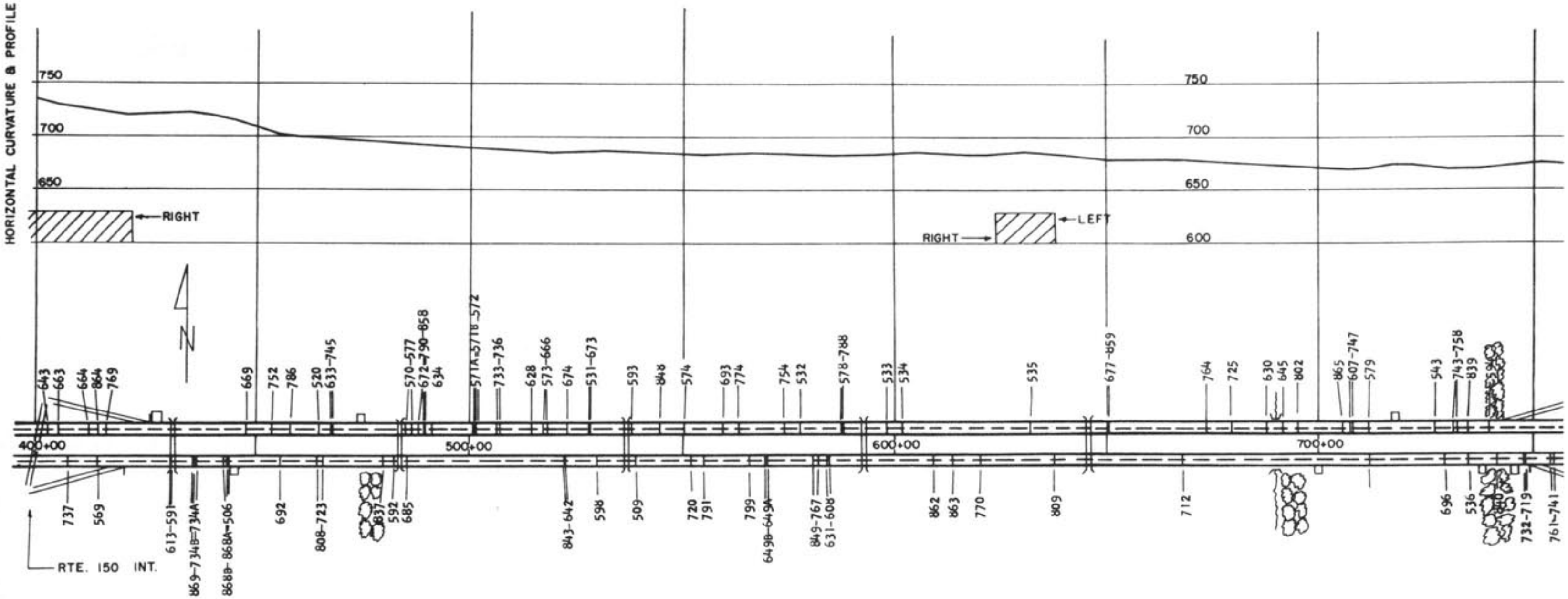
MAP 1. F.A.I. ROUTE 74 AND U.S. ROUTE 66



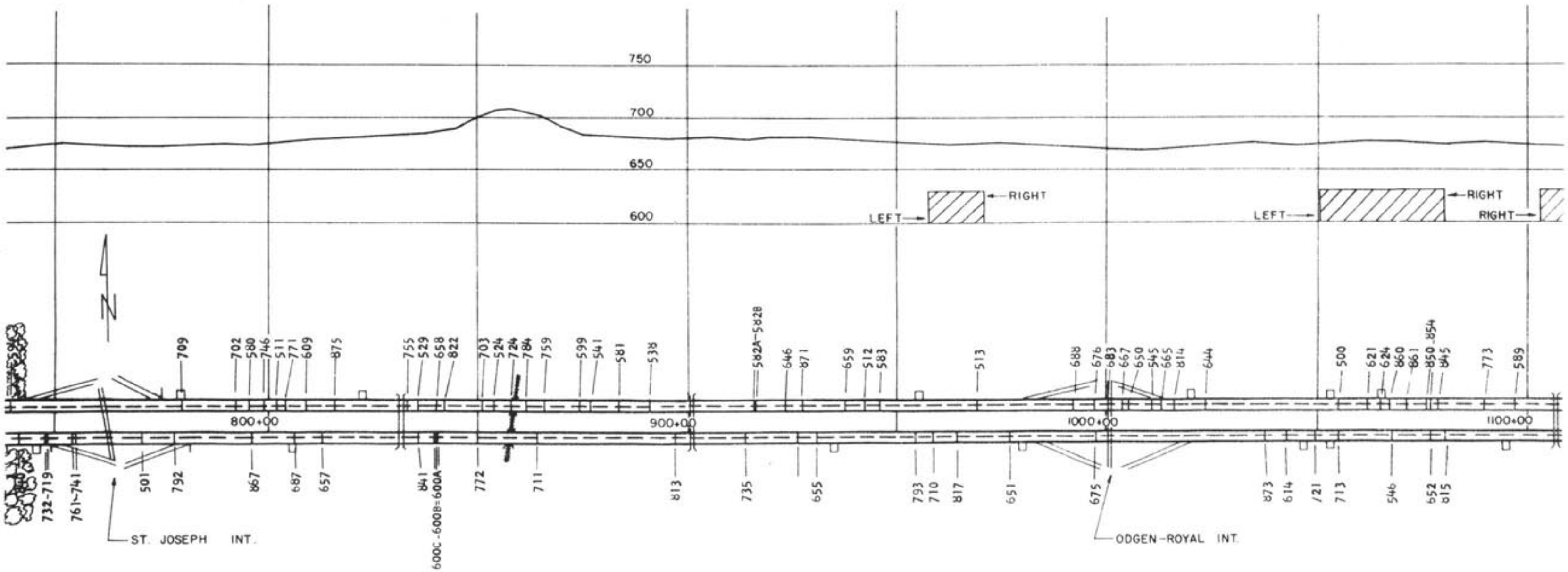
MAP 2. F.A.I. ROUTE 57



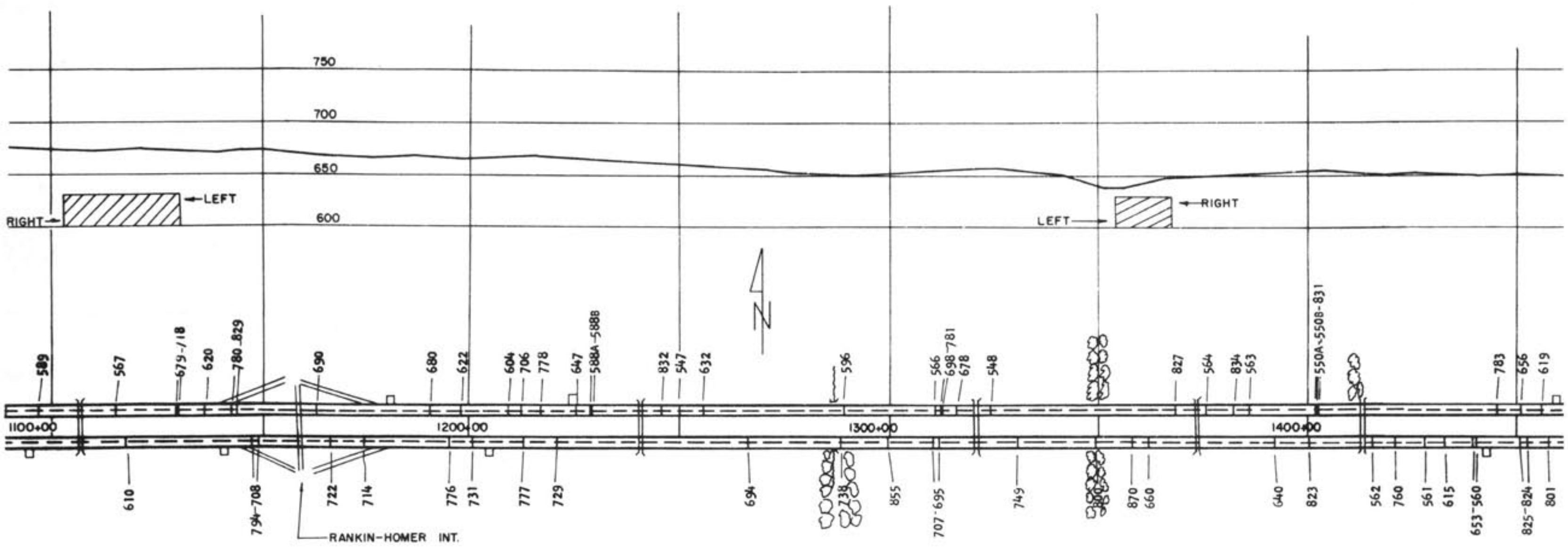
MAP 3. KINGERY EXPRESSWAY



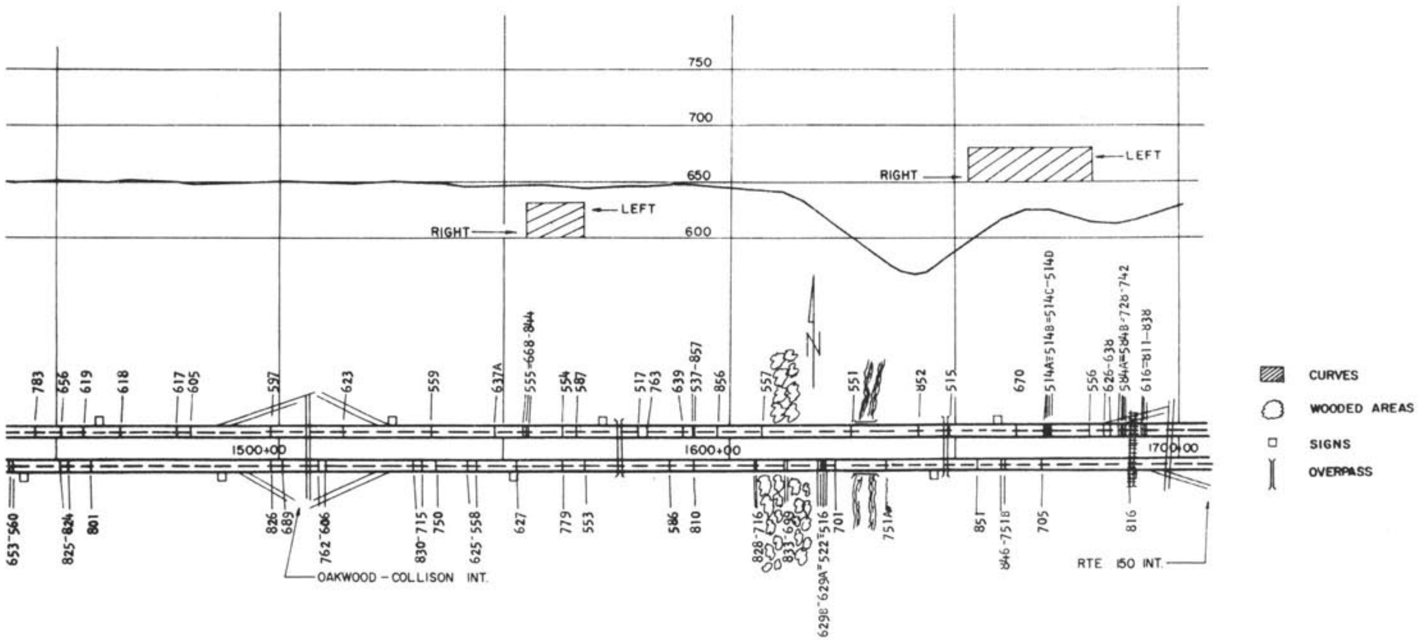
MAP 4. STRIP MAP OF F.A.I. ROUTE 74



MAP 4. CONTINUED



MAP 4. CONTINUED



MAP 4. CONTINUED

TABLE 1.

ENCROACHMENT FREQUENCY AND RATE DATA

HIGHWAY	MILES OF HIGHWAY OBSERVED	PERIOD OF OBSERVATION	NUMBER OF DAYS OF OBSERVATION	TRAFFIC VOLUME (ADT) Vehicles/Day	VEHICLE-MILES OF TRAVEL	NUMBER OF OBSERVED ENCROACHMENTS	ENCROACHMENT FREQUENCY Enc./Mi./Yr.	ENCROACHMENT RATE Enc./100x10^6 Veh.Mi.
FAI 74	24.6	Oct. 4, 1960 - Dec. 22, 1960	79	1,900	3,693,000	16	3.0	433
FAI 74	24.6	Dec. 22, 1960 - March 29, 1961	97	3,000	7,159,000	31	4.7	433
FAI 74	24.6	March 29, 1961 - July 12, 1961	105	4,000	10,332,000	58	8.2	561
FAI 74	24.6	July 12, 1961 - Dec. 2, 1961	143	4,150	14,599,000	30	3.1	205
FAI 74	24.6	Dec. 2, 1961 - March 31, 1962	119	4,350	12,734,000	32	4.0	251
FAI 74	24.6	March 31, 1962 - June 26, 1962	87	5,250	11,236,000	17	2.9	151
FAI 74	24.6	June 26, 1962 - Oct. 13, 1962	109	5,750	15,418,000	16	2.2	104
FAI 74	24.6	Oct. 13, 1962 - April 16, 1963	185	5,950	27,078,000	50	4.0	185
FAI 74	24.6	April 16, 1963 - June 27, 1963	72	5,950	10,539,000	5	1.0	47
FAI 74	24.6	June 27, 1963 - April 6, 1964	284	5,700	39,822,000	47	2.4	118
Kingery Expressway	3.0	Dec. 1, 1957 - March 31, 1958	120	18,195	6,550,000	7*	7.1	107
Kingery Expressway	3.0	Dec. 1, 1958 - March 31, 1959	120	20,490	7,376,000	9	9.1	122
Kingery Expressway	3.0	Dec. 1, 1959 - March 31, 1960	121	31,253	11,345,000	14	14.1	123

*Imcomplete Record

TABLE 2.

ENCROACHMENT RATE

Calumet Expressway ADT = 12,000	58
Edens Expressway ADT = 26,030	61
Santa Ana Freeway Approximate ADT = 95,000	54
Nimitz Freeway Approximate ADT = 95,000	68

*Encroachments/100 x 10^6 Vehicle Miles

TABLE 3.

SUMMARY OF SIGNIFICANT MOVEMENTS AND EVENTS ASSOCIATED WITH ENCROACHMENTS OCCURING ON F.A.I. ROUTES 74 AND 57

		HIGHWAY	
GENERAL		F.A.I. 74	F.A.I. 57
1.	Total number of detected encroachments	302	26
2.	Total number of detected encroachments with sufficient evidence for analysis	293	25
3.	Number and per cent of encroaching vehicles (Item 2) which		
	a. Crossed median or lateral extent of movement greater than 40 feet	52(17.7%)	0(0%)
	b. Struck major obstacles	35(11.9%)	4(16%)
	c. Made a recovery-to-right	185(63.1%)	18(72%)
	d. Crossed original lanes of travel	13(4.4%)	1(4%)
	e. Left roadway to the right prior to median encroachment	9(3.1%)	3(12%)
	f. Had just entered roadway from interchange entrance ramp	9(3.1%)	0(0%)
CROSS MEDIAN ENCROACHMENTS OR LATERAL EXTENTS OF MOVEMENT > 40 FEET			
1.	Total number of encroachments	52	0
2.	Number and per cent of encroachments (Item 1) which		
	a. Struck obstacles prior to crossing	3(5.8%)	0(0%)
	b. Made a recovery-to-right prior to crossing	5(9.6%)	0(0%)
	c. Re-entered original lanes of travel after crossing	2(3.8%)	0(0%)
	d. Left roadway to the right prior to median encroachment	2(3.8%)	0(0%)
	e. Had just entered roadway from interchange entrance ramp	4(7.7%)	0(0%)
ENCROACHMENTS WITH A RECOVER-TO-RIGHT			
1.	Total number of encroachments	185	18
2.	Number and per cent of encroachments (Item 1) which		
	a. Crossed median after recovery	5(2.7%)	0(0%)
	b. Crossed median after striking obstacle subsequent to recovery	2(1.1%)	0(0%)
	c. Crossed original lanes of travel	13(7.0%)	1(5.6%)
	d. Crossed original lanes of travel after striking obstacle subsequent to recovery	1(0.5%)	0(0%)

TABLE 4.

SUMMARY OF BASIC STATISTICAL PARAMETERS ASSOCIATED

WITH THE NATURE OF ENCROACHMENTS

	NUMBER OF ENCROACHMENTS*			AVERAGE			STANDARD DEVIATION			CONFIDENCE INTERVAL Coefficient of Confidence = 0.95		
	FAI 57	FAI 74	FAI 57 and 74	FAI 57	FAI 74	FAI 57 and 74	FAI 57	FAI 74	FAI 57 and 74	FAI 57	FAI 74	FAI 57 and 74
ENCROACHMENT ANGLE (degrees)	25	289	314	10.2	11.0	10.9	9.6	11.1	11.0	6.2 to 14.1	9.7 to 12.2	9.7 to 12.1
LENGTH OF TRAVEL (feet)	25	290	315	292	291	291	202	217	216	209 to 376	266 to 316	267 to 315
LATERAL EXTENT OF TRAVEL (feet)	25	296	321	23	23	23	10	11	11	19 to 27	22 to 24	22 to 24

*The 3 basic parameters could not be measured for all detected encroachments.

TABLE 5.

OBSERVATIONS OF VEHICLE BEHAVIOR AT ROADSIDE SIGN

DATE	METHOD	NUMBER OF VEHICLES OBSERVED	NUMBER SHIFTING TO LEFT	PER CENT
11/ 9/63	Manual Observer	50	13	26
2 / 7/64	Photographic	10	5	50
2 /22/64	Photographic	32	10	31
	TOTAL	92	28	30

TABLE C1.

SUMMARY OF ENCROACHMENT DATA FOR F.A.I. ROUTE 74 (TEST SECTION)

(a) Station Number

(b) See Definitions

(c) Encroachment may have been influenced by (1) the vehicle straddling or passing over an obstacle without an actual collision; or (2) the driver's taking evasive action in order to miss an obstacle.

(d) See Encroachment Classification Code, Appendix D

SPEED LIMIT = 70 MPH MEDIAN CHARACTERISTICS: WIDTH = 40 ft, DEPTH ≈ 3 ft, SHOULDER WIDTH = 8', TYPE OF SURFACE = TURF

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	ENCROACHMENT ANGLE (degrees) OUT	EXTENT OF TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (c)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
500	1055+00	Car	3.0	None	24	261	24	261	Culvert Headwall	Earth Berm	10-17-60	Ac	(Westbound)
501	771+00	Car	1.9	11.3	19	440	19	285	None	None	10-17-60	B3b	(Eastbound)
506	442+50	Car	14.0	33.7	>40	170	22	95	Culvert Headwall	None	11-17-60	C33d	(Eastbound)
509	539+00	Car	27.0	None	19	40	19	40	Bridge Pier	None	11-17-60	Ac	(Eastbound)
511	802+00	Car	3.0	None	32	465	32	255	Culvert Headwall	Culvert Headwall	11-17-60	B3c	(Westbound)
512	942+00	Car	27.0	None	32	75	32	75	None	None	11-17-60	Ac	(Westbound) Snow Cover on Median
513	969+00	Car	18.4	None	22	70	22	70	None	None	11-17-60	Ac	(Westbound) Snow Cover on Median
514A	1669+00	Car	0.7	4.8	6	483	6	350	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median
514B	1669+00	Car	1.6	1.2	5	513	5	320	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median
514C	1669+00	Car	2.4	23.2	10.5	363	10.5	240	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median
514D	1669+00	Car	5.7	2.6	4.5	330	4.5	275	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median
515	1648+00	Car	18.4	18.4	21	102	21	60	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
516	1619+00	Car	4.4	26.0	17	435	17	322	None	None	12-12-60	B3b	(Eastbound) Snow Cover on Median
517	1579+00	Car	23.2	23.0	19	93	19	50	None	None	12-12-60	B3b	(Westbound) Snow Cover on Median Vehicle Sliding Sideways Upon Leaving Roadway
520	465+00	Truck	2.4	None	34	264	34	264	None	None	12-15-60	Ac	(Westbound) Snow Cover on Median
522	1619+00	Truck	2.1	None	31	582	31	582	None	None	12-22-60	B3c	(Eastbound) Snow Cover on Median
524	854+00	Truck	0.6	None	11	228	11	228	None	None	1-24-61	Ac	(Westbound)
529	836+00	Truck	0.4	4.8	10	472	10	358	None	None	1-25-61	B3b	(Westbound) Snow Cover on Median
531	528+00	Car	3.2	None	20	201	20	201	None	None	2- 9-61	Ac	(Westbound) Snow Cover on Median
532	578+00	Car	1.2	30.0	31	426	31	312	Earth Berm	Earth Berm	2- 9-61	B3b	(Westbound) Snow Cover on Median
533	598+00	Truck	1.0	26.6	25	402	25	324	None	None	2- 9-61	B3b	(Westbound) Snow Cover on Median
534	602+00	Car	2.9	33.7	25	426	25	312	None	None	2- 9-61	B3b	(Westbound) Snow Cover on Median
535	632+00	Car	14.5	None	30	270	30	156	None	None	2- 9-61	B3c	(Westbound) Snow Cover on Median
536	735+00	Car	11.3	11.3	10	120	10	60	None	None	2- 9-61	B3b	(Eastbound) Snow Cover on Median
537	1591+00	Car	4.1	45.0	24	NA	24	NA	None	None	2- 9-61	B3b	(Westbound) Snow Cover on Median
538	891+00	Car	3.2	21.8	24	414	24	282	None	None	2- 9-61	B3b	(Westbound) Snow Cover on Median
541	877+00	Car	3.4	26.6	16	285	16	228	None	None	3-16-61	B3b	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
542	926+00	Car	18.4	None	20	63	20	63	None	None	3-16-61	Ac	(Eastbound)
543	727+00	Car	3.6	26.6	8	186	8	120	None	None	3-16-61	B3b	(Westbound)
544	712+00	Truck	9.5	None	22	264	22	264	None	None	3-16-61	Ac	(Eastbound)
545	1011+00	Car	2.7	6.4	30	534	30	360	Culvert Headwall	None	3-16-61	B3b	(Westbound)
546	1068+00	Car	4.4	None	24	303	24	198	Culvert Headwall	Culvert Headwall	3-16-61	C33c	(Eastbound)
547	1249+00	Car	4.8	45.0	17	321	17	216	Earth Berm & Culvert Headwall	None	3-16-61	B3b	(Westbound)
548	1323+00	Car	45.0	None	22	33	22	33	None	None	3-16-61	Ac	(Westbound)
550A	1401+00	Car	3.6	None	25	411	25	255	None	None	3-16-61	Ac	(Westbound)
550B	1401+00	Car	3.8	None	20	336	20	291	None	None	3-29-61	Ac	(Westbound)
551	1625+55	Car	14.5	None	>40	345	>40	195	None	None	3-29-61	B4c	(Westbound) Vehicle Crossed Paved Invert Twice
553	1567+00	Car	7.1	11.3	22	492	22	204	Drop Inlet	Drop Inlet	3-29-61	B3b	(Eastbound)
554	1562+25	Car	18.4	None	28	90	28	90	None	None	3-29-61	Ac	(Westbound)
555	1554+00	Car	4.8	None	25	252	25	201	None	None	3-29-61	B3c	(Westbound)
556	1679+00	Car	23.2	None	28	57	28	57	None	None	3-29-61	Ac	(Westbound) Vehicle Sliding Sideways upon Leaving Roadway
557	1606+00	Car	11.3	None	25	55	25	55	None	None	3-29-61	Ac	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
558	1543+50	Car	8.1	NA	>40	168	>40	168	None	None	3-29-61	Ad	(Eastbound)
559	1533+50	Car	20.6	None	23	84	23	84	None	None	3-29-61	Ac	(Westbound)
560	1439+00	Car	1.0	None	28	375	28	354	Culvert Headwall	Culvert Headwall	3-29-61	B3c	(Eastbound)
561	1427+00	Car	4.4	None	29	162	29	162	None	None	3-29-61	Ac	(Eastbound)
562	1414+50	Car	3.8	None	23	426	23	258	Bridge Pier	None	3-29-61	C333c	(Eastbound)
563	1365+00	Car	2.4	3.6	30	705	30	381	None	None	4-13-61	B3b	(Westbound)
564	1374+25	Car	26.6	None	34	108	25	69	Culvert Headwall & Bridge Pier	None	4-13-61	C33c	(Westbound) Vehicle Sliding Sideways Upon Leaving Roadway
566	1310+00	Car	6.4	14.5	18	180	18	120	Drop Inlet	None	4-13-61	B3b	(Westbound)
567	1115+00	Car	14.5	None	32	111	32	81	None	None	4-13-61	B3c	(Westbound)
569	414+00	Car	18.4	90.0	>40	93	>40	93	None	None	4-18-61	Ad	(Eastbound) Vehicle Could Have Ran Off Of Entrance Ramp
570	487+00	Car	8.1	14.5	18	333	18	213	Bridge Pier	None	4-18-61	B3b	(Westbound)
571A	501+00	Car	6.4	18.4	16	375	16	252	None	None	4-18-61	B3b	(Westbound)
571B	501+00	Car	9.5	5.2	7	150	7	18	None	None	4-18-61	B3b	(Westbound)
572	502+50	Car	5.2	18.4	18	390	18	276	Culvert Headwall	None	4-18-61	B3b	(Westbound)
573	517+00	Car	9.5	14.5	17	264	17	159	None	None	4-18-61	B3b	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
574	550+30	Car	11.3	None	19	114	19	90	Culvert Headwall	None	4-18-61	Ac	(Westbound)
577	485+15	Car	3.4	14.5	19	333	19	219	Bridge Pier	None	4-20-61	B3a	(Westbound) Vehicle Crossed Original Lanes of Travel
578	588+00	Car	8.1	26.6	20	130	20	99	Culvert Headwall	None	4-20-61	B3b	(Westbound)
579	712+00	Car	NA	NA	NA	NA	NA	NA	None	None	4-20-61	NA	(Westbound)
580	795+50	Car	18.4	None	22	51	22	51	None	None	4-20-61	Ac	(Westbound)
581	883+50	Car	3.2	None	20	273	20	273	None	None	4-20-61	Ac	(Westbound)
582A	916+00	Car	6.4	5.2	7	246	7	80	None	None	4-20-61	B3b	(Westbound)
582B	916+00	Car	4.1	45.0	10	405	10	261	None	None	4-20-61	B3b	(Westbound)
583	946+00	Car	4.8	45.0	26	381	26	237	None	None	4-20-61	C33333b	(Westbound)
584A	1687+00	Car	45.0	None	27	106	27	48	None	None	4-27-61	B3c	(Westbound) Vehicle Ran Off Entrance Ramp
584B	1687+00	Truck	6.4	18.4	8	357	8	275	None	None	4-27-61	B3b	(Westbound) Vehicle Ran Off Entrance Ramp
586	1586+00	Car	3.0	14.5	23	891	23	400	None	None	4-27-61	B3b	(Eastbound)
587	1565+25	Car	9.5	26.6	17	144	17	102	None	None	4-27-61	B3b	(Westbound)
588A	1228+00	Car	11.3	7.1	7	222	7	120	None	None	4-27-61	B3b	(Westbound)
588B	1228+00	Car	3.8	8.1	8	306	8	204	None	None	4-27-61	B3b	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
589	1096+48	Car	3.8	18.4	20	480	20	369	None	None	4-27-61	B3b	(Westbound)
591	430+70	Car	6.4	None	19	120	19	108	Crossover	Crossover	5- 2-61	Ac	(Eastbound) Involved in Collision Prior to Entering Median
592	482+50	Car	NA	NA	NA	NA	NA	NA	Bridge Pier	None	5- 2-61	NA	(Eastbound)
593	538+00	Car	5.7	11.3	10	171	10	108	Bridge Pier	None	5- 2-61	B3b	(Westbound)
594	740+00	Car	18.4	None	20	108	20	66	Culvert Headwall	Culvert Headwall	5- 2-61	B3c	(Westbound)
596	1288+00	Car	2.7	14.5	15	351	15	258	Bridge Pier	None	5- 2-61	B3b	(Westbound)
597	1497+00	Car	26.6	None	24	.57	24	48	None	None	5-11-61	B3c	(Westbound)
598	530+00	Car	11.3	26.6	>40	123	>40	123	None	None	5-11-61	Ad	(Eastbound)
599	874+00	Truck	3.4	None	34	351	34	240	Drop Inlet	None	5-18-61	B3c	(Westbound) Vehicle Crossed Over Paved Invert
600A	840+00	Car	14.5	18.4	25	339	12	54	Culvert Headwall	None	5-16-61	C333b	(Eastbound)
600B	840+00	Car	7.1	None	12	50	12	50	None	None	5-16-61	Ac	(Eastbound)
600C	840+00	Car	18.4	None	10	30	10	30	None	None	5-16-61	Ac	(Eastbound)
604	1208+50	Car	5.2	None	22	284	22	225	Culvert Headwall	None	5-16-61	B3c	(Westbound)
605	1479+00	Truck	11.3	None	27	160	27	129	Culvert Headwall	None	5-16-61	Ac	(Westbound)
606	1509+00	Car	NA	NA	19	NA	NA	NA	Bridge Pier	None	5-16-61	NA	(Eastbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
607	708+00	Truck	14.5	None	9	36	9	36	Culvert Headwall	None	5-25-61	Ac	(Westbound) Involved in Collision Prior to Entering Median
608	584+50	Truck	11.3	9.5	12	102	12	39	None	None	6-21-61	C333b	(Eastbound)
609	807+90	Car	2.6	11.3	>40	1040	27	336	Culvert Headwall	Culvert Headwall	6-21-61	C334c	(Westbound)
610	1117+20	Car	11.3	None	20	850	8	255	None	None	6-21-61	C32c	(Eastbound) Vehicle Sliding Sideways Upon Leaving Roadway
613	430+70	Car	11.3	None	8	54	8	54	Crossover	None	6-26-61	B3c	(Eastbound)
614	1043+00	Car	11.3	9.5	10	210	10	70	None	None	6-26-61	B3b	(Eastbound)
615	1432+00	Car	4.4	18.4	10	300	10	220	Culvert Headwall	None	6-26-61	B3b	(Eastbound)
616	1690+00	Car	26.6	26.4	>40	60	>40	60	Bridge Pier & Drop Inlet	None	6-26-61	Ae	(Westbound) Vehicle Ran Off of Entrance Ramp
617	1476+00	Truck	9.5	18.4	11	460	11	160	Crossover	None	6-27-61	B3b	(Westbound)
618	1463+00	Truck	11.3	21.8	>40	158	>40	NA	None	None	6-27-61	NA	(Westbound)
619	1455+50	Truck	6.4	None	8	66	8	66	Earth Berm	None	6-27-61	Ac	(Westbound)
620	1136+00	Car	4.4	4.8	9	232	9	160	Crossover & Sign Post	None	6-27-61	B3a	(Westbound) Vehicle Crossed Original Lanes of Travel
621	1061+75	Car	26.6	None	30	39	30	39	None	None	6-27-61	Ac	(Westbound)
622	1197+00	Car	18.4	None	22	72	22	50	None	None	7- 5-61	B3c	(Westbound)
623	1513+50	Car	4.8	NA	>40	280	>40	280	None	None	7-12-61	Ad	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
624	1065+40	Car	18.4	None	28	196	28	56	None	None	7-12-61	Ac	(Westbound)
625	1541+00	Car	4.4	11.3	10	330	10	231	None	None	7-12-61	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
626	1684+00	Car	4.8	11.3	>40	381	>40	381	None	None	7-12-61	Ad	(Westbound) Vehicle Ran Off Of Entrance Ramp
627	1551+50	Car	5.7	None	22	229	22	229	None	None	7-20-61	Ac	(Eastbound)
628	514+65	Car	NA	NA	>40	NA	>40	NA	None	None	7-26-61	NA	(Westbound)
629A	1619+47	Car	1.1	7.1	>40	819	9	312	Drop Inlet	None	7-26-61	C32d	(Eastbound) Vehicle Crossed Over Paved Invert
629B	1619+47	Car	26.6	None	8	15	8	15	None	None	7-26-61	Ac	(Eastbound) Vehicle Left Roadway to Right Before Entering Median
630	688+00	Car	18.4	26.6	>40	96	>40	96	Bridge Pier	None	7-26-61	Ae	(Westbound)
631	584+00	Car	9.5	14.5	3	54	3	33	None	None	8- 3-61	B3b	(Eastbound)
632	1255+00	Car	4.8	14.5	15	292	15	184	Culvert Headwall	None	8- 3-61	C31a	(Westbound) Vehicle Crossed Original Lanes of Travel Colliding With Two Vehicles
633	467+80	Car	38.7	26.6	>40	78	>40	78	None	None	8-24-61	Ae	(Westbound) Vehicle Left Roadway to the Right Before Entering Median
634	491+18	Car	18.4	NA	NA	NA	NA	NA	None	None	9- 5-61	NA	(Westbound)
637A	1547+00	Car	11.3	90.0	>40	144	>40	144	None	None	9-23-61	Ad	(Westbound)
638	1682+40	Car	8.1	14.5	8	153	8	76	None	None	9-23-61	B3b	(Westbound) Vehicle Ran Off Of Entrance Ramp
639	1588+50	Car	3.0	8.1	>40	495	>40	495	None	None	9-23-61	Ae	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
640	1391+00	Car	6.4	8.1	30	159	4	35	None	None	9-30-61	C32c	(Eastbound)
642	522+36	Car	2.3	NA	32	665	32	425	None	None	10-16-61	B3b	(Eastbound)
643	402+50	Car	3.0	None	30	318	30	297	None	None	10-21-61	B3c	(Westbound)
644	1023+50	Car	NA	None	20	2000+	20	2000+	Crossover & Culvert Headwall	Crossover	10-21-61	Ac	(Westbound)
645	692+00	Car	4.4	26.6	15	312	15	211	Bridge Pier	Bridge Pier	10-21-61	B3a	(Westbound) Vehicle Crossed Original Lanes of Travel
646	923+00	Car	11.3	26.6	>40	390	16	138	None	None	10-31-61	C3333d	(Westbound)
647	1224+50	Truck	2.9	None	25	507	19	252	Culvert Headwall	Culvert Headwall	10-31-61	C333c	(Westbound)
649A	569+50	Car	5.2	9.5	8	126	8	69	None	None	11- 4-61	B3b	(Eastbound)
649B	569+50	Car	NA	None	9	84	9	69	None	None	11- 4-61	B3c	(Eastbound)
650	1005+50	Car	8.1	None	27	241	27	226	None	None	11-4-61	B3c	(Westbound)
651	977+00	Car	3.8	26.6	>40	1053	19	300	Earth Berm & Drop Inlet	Earth Berm & Drop Inlet	11-11-61	C3232e	(Eastbound)
652	1077+00	Car	6.4	None	32	120	32	120	None	None	11-18-61	Ac	(Eastbound)
653	1438+00	Car	8.1	18.4	24	360	24	168	Culvert Headwall	None	11-18-61	C333b	(Eastbound)
655	931+00	Car	3.2	None	>40	489	20	372	Earth Berm & Culvert Headwall	Earth Berm & Culvert Headwall	11-25-61	Ac	(Eastbound)
656	1450+00	Car	18.4	None	28	138	28	108	None	None	11-25-61	B3c	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
657	813+00	Car	11.3	26.6	9	96	9	60	None	None	12- 2-61	B3b	(Eastbound) Vehicle Could Have Run Off Of Entrance Ramp
658	840+00	Car	11.3	26.6	25	291	25	138	Culvert Headwall	None	12- 2-61	C333b	(Westbound)
659	937+50	Car	8.1	None	28	156	28	156	None	None	12- 2-61	Ac	(Westbound)
660	1361+00	Car	14.5	None	23	105	23	90	None	None	12- 9-61	Ac	(Eastbound) Snow Cover on Median
663	405+00	Car	1.0	11.3	15	984	15	774	Bridge Pier & Culvert Headwall	None	1- 2-62	B3b	(Westbound) Snow Cover on Median
664	412+00	Car	4.4	None	32	591	32	363	Culvert Headwall	Culvert Headwall	1- 2-62	C333c	(Westbound) Snow Cover on Median
665	1013+50	Car	6.4	None	26	93	26	78	None	None	1- 2-62	B3c	(Westbound) Snow Cover on Median
666	518+50	Car	11.3	None	21	96	21	96	None	None	1-13-62	Ac	(Westbound)
667	1003+82	Car	9.5	11.3	22	201	22	141	None	None	1-13-62	B3b	(Westbound)
668	1555+00	Car	9.5	14.5	20	246	20	108	None	None	1-13-62	B3b	(Westbound)
669	448+00	Car	14.5	None	12	90	12	90	None	None	1-20-62	Ac	(Westbound)
670	1662+66	Car	1.0	26.6	23	838	23	700	None	None	1-20-62	C333b	(Westbound)
672	489+00	Car	18.4	26.6	>40	114	>40	114	None	None	1-27-62	Ad	(Westbound) Snow Cover on Median
673	528+00	Car	11.3	18.4	22	237	22	167	None	None	1-27-62	B3b	(Westbound) Snow Cover on Median
674	523+00	Car	5.7	None	20	200	20	200	None	None	1-27-62	Ac	(Westbound) Snow Cover on Median

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	ENCROACHMENT ANGLE (degrees) OUT	EXTENT OF TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (c)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
675	997+75	Car	26.6	None	28	53	28	53	Bridge Pier	None	1-27-62	Ac	(Eastbound) Snow Cover on Median. Vehicle Left Roadway to the Right Before Entering Median
676	997+25	Car	45.0	NA	>40	50	>40	50	Bridge Pier	None	1-27-62	Ae	(Westbound) Snow Cover on Median
677	650+00	Car	11.3	18.4	30	387	30	270	None	None	1-28-62	B3b	(Westbound) Snow Cover on Median
678	1315+00	Car	8.1	45.0	15	285	15	171	None	None	2- 2-62	B3b	(Westbound) Snow Cover on Median
679	1129+50	Car	3.6	11.3	10	183	10	117	None	None	2-10-62	B3b	(Westbound)
680	1189+50	Car	3.4	26.6	28	393	28	300	None	None	2-10-62	B3b	(Westbound)
683	1001+00	Car	9.5	18.4	20	543	20	174	Bridge Pier & Culvert Headwall	Culvert Headwall	2-17-62	B3b	(Westbound)
685	486+00	Car	45.0	26.6	30	348	30	63	None	None	2-23-62	B3b	(Eastbound)
687	806+00	Car	18.4	None	30	114	30	114	Culvert Headwall	Culvert Headwall	3-10-62	Ac	(Eastbound)
688	992+00	Car	8.1	26.6	28	309	28	195	Earth Berm & Culvert Headwall	Earth Berm & Culvert Headwall	3-10-62	B3b	(Westbound)
689	1500+00	Car	3.8	26.6	17	459	17	210	None	None	3-10-62	B3b	(Eastbound)
690	1162+50	Car	5.7	26.6	12	225	12	129	Bridge Pier	None	3-10-62	B3b	(Westbound)
692	456+50	Car	NA	9.5	9	NA	9	NA	None	None	3-16-62	NA	(Eastbound)
693	559+50	Car	11.3	26.6	21	606	21	300	Culvert Headwall	Culvert Headwall	3-16-62	B3b	(Westbound)
694	1265+50	Car	26.6	45.0	>40	93	>40	93	None	None	3-16-62	Ad	(Eastbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
695	1311+00	Car	18.4	45.0	30	465	30	165	Earth Berm	None	3-16-62	B3b	(Eastbound)
696	729+50	Car	4.4	None	20	255	20	225	Culvert Headwall	None	3-16-62	Ac	(Eastbound)
698	1311+80	Truck	5.2	None	28	348	28	225	None	None	3-24-62	B3c	(Westbound)
699	1612+50	Car	8.1	6.4	28	420	28	192	None	None	3-24-62	B3b	(Eastbound) Vehicle Crossed Over Paved Invert
701	1622+10	Car	1.9	18.4	8	240	8	168	None	None	3-31-62	B3b	(Eastbound)
702	792+25	Truck	2.9	None	25	420	25	275	Drop Inlet	None	4- 7-62	B3c	(Westbound)
703	851+00	Truck	4.4	None	35	801	20	225	Culvert Headwall	Culvert Headwall	4- 7-62	C333333c	(Westbound)
705	1668+25	Car	18.4	45.0	10	63	10	36	None	None	4- 7-62	B3b	(Eastbound)
706	1211+50	Car	18.4	26.6	>40	417	>40	417	None	None	4-17-62	Ad	(Westbound) Evidence of Blowout
707	1309+50	Car	3.8	11.3	9	378	9	267	Drop Inlet	None	4-17-62	B3b	(Eastbound)
708	1147+15	Car	14.5	9.5	>40	520	>40	190	None	None	4-25-62	B4b	(Eastbound)
709	779+50	Car	7.1	18.4	10	93	10	54	None	None	4-28-62	B3b	(Westbound)
710	958+50	Car	2.9	NA	10	363	10	225	Culvert Headwall	None	4-28-62	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
711	864+00	Car	5.7	14.5	10	324	10	134	None	None	5- 4-62	B3b	(Eastbound)
712	668+00	Car	0.7	7.1	7	462	7	345	Culvert Headwall	None	5-12-62	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
713	1055+00	Car	11.3	26.6	10	189	10	111	None	None	5-12-62	B3b	(Eastbound)
714	1174+00	Car	11.3	26.6	12	246	12	120	None	None	5-12-62	B3b	(Eastbound)
715	1528+50	Car	3.8	None	30	400	30	279	None	None	5-12-62	B3c	(Eastbound)
716	1604+50	Truck	5.2	14.5	14	492	14	300	None	None	5-12-62	B3b	(Eastbound)
718	1129+00	Truck	7.1	None	30	320	22	180	None	None	6-10-62	Ac	(Westbound)
719	748+00	Car	2.3	3.0	10	546	10	234	None	None	6-18-62	B3b	(Eastbound)
720	552+00	Car	18.4	None	25	81	25	81	None	None	6-26-62	Ac	(Eastbound)
721	1049+55	Car	8.1	None	16	273	9	87	None	None	7- 2-62	C33c	(Eastbound)
722	1166+00	Car	3.4	5.2	8	381	8	276	None	None	7- 5-62	B3b	(Eastbound)
723	464+90	Car	7.1	None	14	132	14	132	None	None	7-17-62	Ac	(Eastbound)
724	857+97	Car	NA	None	20	205	2	10	Bridge Rail	Bridge Rail	7-24-62	C3233c	(Westbound)
725	679+75	Car	26.6	26.6	>40	99	>40	99	None	None	7-24-62	Ae	(Westbound)
728	1686+60	Car	26.6	None	20	48	20	48	None	None	8- 7-62	Ac	(Westbound)
729	1220+15	Car	3.6	2.1	10	519	10	183	None	None	8-16-62	B3b	(Eastbound)
731	1201+25	Car	1.4	None	25	948	25	828	None	None	9- 4-62	C333c	(Eastbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	ENCROACHMENT ANGLE (degrees) OUT	EXTENT OF TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (c)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
732	748+50	Truck	4.4	7.1	>40	363	>40	363	None	None	9-10-62	Ad	(Eastbound)
733	506+25	Car	6.4	9.5	24	420	14	165	None	None	9-14-62	C32c	(Westbound)
734A	436+20	Car	45.0	None	30	198	30	198	Crossover & Sign Post	Crossover & Sign Post	9-22-62	Ac	(Eastbound) Involved in Collision with 734B
734B	436+20	Truck	1.9	None	3	20	3	20	Crossover & Sign Post	None	9-22-62	Ac	(Eastbound) Involved in Collision with 734A
735	913+50	Car	4.8	11.3	10	279	10	165	Culvert Headwall	None	9-29-62	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
736	486+00	Car	NA	NA	NA	NA	NA	NA	None	None	10- 2-62	NA	(Westbound)
737	407+00	Car	11.3	18.4	33	261	33	156	Culvert Headwall	None	10-13-62	B3b	(Eastbound)
738	1287+00	Car	45.0	None	25	36	25	36	Bridge Rail	Bridge Rail	10-13-62	Ac	(Eastbound) Vehicle Left Roadway to the Right Hitting Bridge Rail Before Entering Median
741	754+00	Truck	90.0	None	28	33	28	33	None	None	11- 3-62	Ac	(Eastbound) Vehicle Left Roadway to the Right Before Entering Median
742	1686+00	Car	6.4	None	28	149	28	149	Drop Inlet & Sign Post	Sign Post	11- 3-62	Ac	(Westbound)
743	732+00	Car	5.2	14.5	30	777	30	315	Culvert Headwall	None	11- 3-62	C33323b	(Westbound)
745	468+00	Truck	2.7	5.7	30	606	30	363	None	None	11-10-62	B3b	(Westbound)
746	799+00	Car	2.1	9.5	35	720	9	243	Culvert Headwall	Culvert Headwall	11-10-62	C32c	(Westbound)
747	707+50	Truck	4.8	9.5	12	447	12	279	None	None	12- 1-62	B3b	(Westbound)
749	1329+50	Car	14.5	63.4	>40	90	>40	90	None	None	12- 8-62	Ad	(Eastbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
750	1533+80	Car	4.8	None	25	270	25	270	Culvert Headwall	Culvert Headwall	12-15-62	Ac	(Eastbound)
751A	1633+50	Car	14.5	None	35	507	24	150	None	None	12-22-62	C33c	(Eastbound) Vehicle Crossed Over Paved Invert
751B	1660+25	Car	14.5	45.0	18	423	18	270	None	None	12-30-62	B3a	Snow Cover on Median. (Eastbound) Vehicle Crossed Original Lanes of Travel
752	453+80	Truck	3.8	18.4	19	453	19	288	Earth Berm	Earth Berm	1- 5-63	B3b	(Westbound) Snow Cover on Median
754	574+00	Car	11.3	14.5	27	220	27	123	None	None	1-12-63	B3b	(Westbound) Icy Cover on Median
755	833+00	Car	45.0	None	15	55	15	55	Bridge Pier	Bridge Pier	1-12-63	Ac	(Westbound)
758	731+54	Car	5.7	5.7	12	312	12	189	None	None	1-31-63	B3b	(Westbound)
759	866+00	Car	5.7	8.1	14	225	14	165	None	None	1-31-63	B3b	(Westbound)
760	1420+00	Car	3.8	5.7	10	480	10	315	None	None	1-31-63	B3b	(Eastbound)
761	755+00	Car	1.9	16.7	10	326	10	305	None	None	2- 1-63	B3b	(Eastbound) Snow Cover on Median
762	1508+00	Car	2.5	9.5	5	501	5	315	None	None	2- 1-63	B3b	(Eastbound) Snow Cover on Median
763	1581+00	Car	1.8	45.0	20	294	20	258	None	None	2- 1-63	B3b	(Westbound) Snow Cover on Median
764	674+00	Truck	2.4	2.9	7	411	7	219	None	None	2- 1-63	B3b	(Westbound) Snow Cover on Median
767	581+00	Car	45.0	None	21	30	21	30	None	None	2- 2-63	Ac	Vehicle Left Roadway to the (Eastbound) Right Before Entering Median
769	416+00	Car	2.7	26.6	>40	336	>40	336	Earth Berm	None	2- 5-63	Ad	(Westbound) Snow Cover on Median

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
770	620+40	Truck	4.8	None	20	480	20	363	Drop Inlet	Drop Inlet	2- 5-63	Ac	(Eastbound) Snow Cover on Median
771	804+10	Car	9.5	14.5	>40	192	>40	192	None	None	2- 5-63	Ad	(Westbound) Snow Cover on Median
772	850+00	Car	6.4	NA	13	315	13	195	None	None	2- 5-63	B3b	(Eastbound) Snow Cover on Median
773	1089+50	Car	8.1	None	22	189	22	189	None	None	2- 5-63	Ac	(Westbound) Snow Cover on Median
774	563+50	Car	14.5	18.4	22	198	20	84	None	None	2- 9-63	B3b	(Westbound)
776	1194+00	Car	1.0	None	28	237	28	168	Culvert Headwall	None	2- 9-63	B3c	(Eastbound)
777	1212+00	Truck	18.4	None	26	120	26	66	None	None	2- 9-63	B3c	(Eastbound)
778	1216+00	Car	3.8	18.4	28	452	28	300	Earth Berm	Earth Berm	2- 9-63	B3b	(Westbound)
779	1562+00	Truck	3.8	14.5	>40	636	>40	636	None	None	2-16-63	Ad	(Eastbound) Snow Cover on Median
780	1142+50	Truck	6.4	None	>40	300	>40	210	None	None	2-21-63	Ac	(Westbound)
781	1311+70	Truck	8.1	18.4	30	360	30	189	None	None	2-21-63	B3b	(Westbound)
783	1443+75	Car	26.6	26.6	>40	123	>40	123	None	None	2-23-63	Ad	(Westbound) Snow Cover on Median
784	862+00	Truck	3.8	NA	4	310	4	180	Bridge Rail	Bridge Rail	2-26-63	B3b	(Westbound) Snow Cover on Median Blowout on Left Front
786	458+00	Car	NA	NA	NA	NA	NA	NA	Earth Berm	Earth Berm	2-26-63	B3c	(Westbound) Snow Cover on Median. Vehicle Traveled 2ift. in the Air After Hitting Berm.
788	587+50	Car	7.1	45.0	31	390	31	276	Culvert Headwall	None	3- 2-63	B3b	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
790	488+00	Car	4.8	26.6	>40	220	>40	220	None	None	3- 9-63	Ad	(Westbound)
791	555+00	Car	1.0	None	22	465	10	465	None	None	3- 9-63	Ac	(Eastbound)
792	778+00	Car	18.4	None	10	108	10	42	None	None	3- 9-63	B3c	(Eastbound)
793	954+20	Car	11.3	5.7	23	370	23	189	None	None	3- 9-63	B3b	(Eastbound)
794	1148+60	Truck	18.4	18.4	10	135	10	48	None	None	3- 9-63	B3b	(Eastbound)
799	566+00	Car	5.7	None	22	330	22	195	None	None	3-23-63	B3c	(Eastbound)
800	1348+50	Car	1.0	11.3	27	525	27	375	None	None	3-23-63	B3b	(Eastbound)
801	1456+90	Car	0.6	14.5	6.5	375	6.5	342	None	None	3-23-63	B3b	(Eastbound)
802	695+30	Car	5.7	26.6	22	342	22	180	None	None	3-30-63	B3b	(Westbound)
808	466+00	Car	11.3	45.0	>40	168	>40	168	None	None	4-16-63	Ad	(Eastbound)
809	638+00	Truck	3.8	None	21	345	21	219	Culvert Headwall	Culvert Headwall	4-16-63	B3c	(Eastbound)
810	1592+00	Car	7.1	5.7	10	333	10	105	None	None	4-16-63	B3b	(Eastbound)
811	1690+00	Car	18.4	None	16	105	16	84	None	None	4-16-63	B3c	(Westbound) Vehicle Ran Off Of Entrance Ramp
813	897+00	Car	11.3	26.6	>40	310	>40	310	None	None	5-25-63	Ae	(Eastbound)
814	1016+00	Truck	11.3	None	20	168	20	168	None	None	6-20-63	Ac	(Westbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
815	1081+00	Truck	7.1	NA	NA	NA	NA	NA	None	None	6-20-63	NA	(Eastbound)
816	1688+50	Car	45.0	None	20	25	20	25	Bridge Pier	Bridge Pier	6-20-63	Ac	(Eastbound) Vehicle Ran Off Right, Hit Outside Pier, Crossed Roadway, Hit Center Pier.
817	964+00	Car	26.6	None	30	105	30	55	None	None	6-20-63	Ac	(Eastbound)
822	842+00	Car	14.5	45.0	23	412	23	240	None	None	7-20-63	B3b	(Westbound)
823	1399+00	Car	8.1	14.5	11	306	11	180	Culvert Headwall	None	7-20-63	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
824	1450+00	Car	9.5	26.6	>40	255	>40	255	None	None	7-20-63	Ad	(Eastbound)
825	1452+00	Car	9.5	26.6	>40	255	>40	255	None	None	7-20-63	Ad	(Eastbound)
826	1497+00	Car	18.4	26.6	>40	290	>40	290	None	None	7-20-63	Ad	(Eastbound)
827	1367+50	Car	8.1	14.5	>40	282	>40	282	None	None	7-30-63	Ad	(Westbound)
828	1606+00	Car	7.1	14.5	12	366	12	225	Drop Inlet	None	8-16-63	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
829	1144+00	Truck	3.6	11.3	14	474	14	330	None	None	8-16-63	B3b	(Westbound) Vehicle Could Have Run Off of Entrance Ramp
830	1531+00	Truck	11.3	45.0	>40	153	>40	153	None	None	8-23-63	Ad	(Eastbound)
831	1400+00	Car	18.4	45.0	>40	156	>40	156	None	None	9-14-63	Ad	(Westbound)
832	1245+00	Truck	14.5	26.6	>40	138	>40	138	None	None	9-21-63	Ad	(Westbound)
833	1612+00	Truck	45.0	45.0	>40	150	>40	150	None	None	9-21-63	Ad	(Eastbound)

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
834	1381+00	Truck	9.5	NA	>40	267	>40	267	None	None	9-24-63	Ae	(Westbound)
837	480+00	Car	11.3	26.6	>40	195	>40	195	None	None	9-28-63	Ad	(Eastbound)
838	1691+00	Car	45.0	45.0	>40	138	>40	138	Drop Inlet	None	9-28-63	Ad	(Westbound) Vehicle Ran Off of Entrance Ramp
839	735+00	Car	1.4	11.3	>40	432	>40	432	None	None	10-26-63	Ad	(Westbound)
840	742+00	Car	9.5	90.0	>40	228	>40	228	None	None	10-26-63	Ad	(Eastbound)
841	836+00	Car	3.6	8.1	8	126	8	60	None	None	10-26-63	B3b	(Eastbound)
843	522+50	Car	9.5	None	19	200	19	105	None	None	11- 9-63	B3c	(Eastbound)
844	1553+50	Car	5.7	26.6	28	423	28	261	None	None	11- 9-63	B3b	(Westbound)
845	1079+50	Car	14.5	26.6	11	226	11	150	None	None	11-23-63	B3b	(Westbound)
846	1659+00	Car	6.4	26.6	12	229	12	108	None	None	11-23-63	B3a	(Eastbound) Vehicle Crossed Original Lanes of Travel
848	543+50	Truck	4.8	5.7	>40	432	>40	432	None	None	12- 7-63	Ad	(Westbound)
849	582+00	Car	9.5	45.0	>40	264	>40	264	None	None	12- 7-63	Ad	(Eastbound)
850	1076+00	Car	6.4	None	39	441	39	327	Culvert Headwall	Culvert Headwall	12- 7-63	B3c	(Westbound)
851	1654+00	Car	8.1	26.6	20	362	20	240	None	None	12- 7-63	B3b	(Eastbound)
852	1641+00	Car	2.0	6.4	8	537	8	390	None	None	12- 7-63	B3a	(Westbound) Vehicle Crossed Original Lanes of Travel

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	ENCROACHMENT ANGLE (degrees) OUT	EXTENT OF TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (c)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
854	1075+60	Car	18.4	None	21	63	21	63	None	None	12-21-63	Ac	(Westbound) Snow Cover on Median. Involved in Collision Before Entering Median
855	1298+50	Car	45.0	None	21	82	21	78	None	None	12-21-63	Ac	(Eastbound) Snow Cover on Median
856	1596+00	Car	11.3	None	28	162	28	162	Crossover	None	12-21-63	Ac	(Westbound) Snow Cover on Median
857	1591+00	Car	4.8	None	30	440	30	360	None	None	12-21-63	B3c	(Westbound) Snow Cover on Median
858	489+00	Car	26.6	63.4	>40	124	>40	124	None	None	1- 4-64	Ad	(Westbound) Vehicle Left Roadway to the Right Before Entering Median
859	651+00	Car	9.5	None	24	480	24	120	None	None	1-11-64	C33c	(Westbound)
860	1067+00	Car	14.5	26.6	15	243	15	147	None	None	1-11-64	B3b	(Westbound)
861	1071+00	Car	NA	26.6	>40	585	>40	438	Culvert Headwall	None	1-11-64	B4b	(Westbound)
862	609+00	Car	NA	NA	22	NA	22	NA	None	None	1-20-64	Ac	(Eastbound) Snow Cover on Median
863	614+00	Car	5.7	3.2	9	174	9	72	Crossover	None	2- 1-64	C333b	(Eastbound)
864	414+00	Car	3.8	26.6	17	432	17	321	Culvert Headwall	None	2- 8-64	B3b	(Westbound)
865	706+00	Truck	5.2	None	28	303	28	279	None	None	2- 8-64	B3c	(Westbound)
867	794+00	Car	8.1	26.6	28	361	28	184	Culvert Headwall	None	2-15-64	C333b	(Eastbound) Snow Cover on Median
868A	444+00	Car	11.3	26.6	21	222	21	184	Earth Berm	Earth Berm	2-19-64	B3b	(Eastbound) Snow Cover on Median
868B	444+00	Car	45.0	None	30	42	30	42	Culvert Headwall	None	2-19-64	Ac	(Eastbound) Snow Cover on Median

TABLE C1. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
869	436+00	Truck	26.6	None	23	72	23	72	Crossover	None	2-19-64	Ac	(Eastbound) Snow Cover on Median
870	1357+00	Car	3.8	11.3	8	162	8	120	None	None	2-22-64	B3b	(Eastbound) Snow Cover on Median
871	927+00	Car*	NA	None	22	NA	22	NA	None	None	2-22-64	Ac	(Westbound) Snow Cover on Median
873	1037+50	Car	18.4	None	15	190	15	45	None	None	4- 6-64	C33c	(Eastbound)
875	816+00	Car	11.3	None	24	240	24	240	Culvert Headwall	None	4- 6-64	Ac	(Westbound)

TABLE C2.

SUMMARY OF ENCROACHMENT DATA FOR F.A.I. ROUTE 74 (OUTSIDE TEST SECTION)

(a) Station Number

(b) Encroachment may have been influenced by (1) the vehicle straddling or passing over an obstacle without an actual collision; or (2) the driver's taking evasive action in order to miss an obstacle.

(c) See Encroachment Classification Code, Appendix D

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (c)	REMARKS
497	286+00	26	2.5	6	Turf	Car	4.3	None	16	245	3-Cable Median Barrier	3-Cable Median Barrier	7-21-60	Ac	(Eastbound)
498	318+00	4	-0.5	None	Paved	Car	45.0	45.0	>4	4	None	None	7-25-60	NA	(Westbound)
519	188+00	40	3.0	8	Turf	Car	5.2	26.6	24	342	None	None	12-15-60	C333b	(Westbound) Snow Cover on Median
521	368+00	40	3.0	8	Turf	Car	0.8	None	15	402	None	None	12-15-60	Ac	(Westbound) Snow Cover on Median
525	299+00	12	1.0	None	Turf	Car	13.6	None	8	49	Guard Rail	Guard Rail Posts	1-25-61	C33c	(Eastbound)
526	295+00	14	1.0	None	Turf	Car	NA	NA	NA	NA	Guard Rail	Guard Rail Posts	1-25-61	NA	(Westbound)
527	295+00	23	0.0	8	Turf	Car	6.4	None	9	69	Guard Rail	Guard Rail Posts	1-25-61	Ac	(Westbound)
528	364+00	40	2.5	8	Turf	Car	21.8	27.0	>40	138	None	None	1-25-61	Ae	(Eastbound) Snow Cover on Median
530A	267+50	40	3.0	8	Turf	Car	14.5	None	>40	204	None	None	1-30-61	Ae	(Westbound) Snow Cover on Median
530B	267+50	40	3.0	8	Turf	Car	8.1	None	29	96	None	None	1-30-61	Ac	(Westbound) Snow Cover on Median
539	384+06	40	2.5	8	Turf	Car	7.1	None	6	60	None	None	3- 9-61	Ac	(Eastbound) Snow Cover on Median
540	362+00	40	3.0	8	Turf	Truck	3.6	None	25	177	None	None	3- 9-61	Ac	(Eastbound) Snow Cover on Median

TABLE C2. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS				TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		TRAVEL IN MEDIAN (ft)		MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (c)	REMARKS
		WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE		IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INFLUENCE (b)	COLLISION			
568	384+00	40	3.0	8	Turf	Car	53.1	26.6	15	66	None	None	4-18-61	B3b	(Eastbound)
575	356+40	40	3.5	8	Turf	Car	3.4	9.5	9	219	Bridge Pier	None	4-20-61	B3b	(Westbound)
576	368+75	40	3.0	8	Turf	Car	11.3	None	20	60	None	None	4-20-61	Ac	(Westbound)
590	395+00	40	4.0	8	Turf	Car	6.4	26.6	24	285	None	None	5- 2-61	B3b	(Westbound)
601	194+25	24	1.0	3	Turf	Car	NA	NA	15	NA	Wire Barrier	Wire Barrier	5-16-61	NA	(Eastbound)
602	292+45	27	1.5	8	Turf	Car	NA	NA	16	NA	Wire Barrier	Wire Barrier	5-16-61	NA	(Eastbound)
603	385+00	40	3.5	8	Turf	Car	1.7	None	31	552	Drop Inlet	Drop Inlet	5-16-61	C33c	(Westbound)
611	116+75	40	3.0	8	Turf	Car	11.3	None	NA	NA	None	None	6-26-61	NA	(Eastbound)
612A	178+50	40	3.0	8	Turf	Car	3.6	6.4	12	303	Crossover With Barrier	Crossover With Barrier	6-26-61	B3b	(Eastbound)
612B	178+50	40	3.0	8	Turf	Car	8.1	11.3	5	93	Crossover With Barrier	None	6-26-61	C323b	(Eastbound)
635	348+00	40	3.0	8	Turf	Car	9.5	11.3	>40	188	None	None	9-23-61	Ad	(Westbound)
641	204+06	4	-0.5	None	Paved	Car	NA	NA	0	18	Raised Median	Raised Median	10-16-61	B3a	(Eastbound)
654	177+50	40	3.5	8	Turf	Car	11.3	None	19	63	Drop Inlet	None	11-25-61	Ac	(Eastbound)
661	224+10	4	-0.5	None	Paved	Car	NA	NA	2	15	Raised Median and Bridge Rail	Raised Median and Bridge Rail	12-16-61	B3b	(Eastbound)
671	376+00	40	3.0	8	Turf	Car	7.1	None	28	325	Bridge Pier	None	1-27-62	B3c	(Westbound) Snow Cover on Median

TABLE C2. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (c)	REMARKS
681	175+02	40	3.0	8	Turf	Car	2.3	None	25	420	None	None	2-17-62	Ac	(Eastbound)
682	275+00	40	3.0	8	Turf	Car	11.3	26.6	30	192	None	None	2-17-62	B3b	(Westbound)
684	350+00	40	3.0	8	Turf	Car	90.0	90.0	>40	42	None	None	2-17-62	Ad	(Eastbound)
686	139+00	40	3.0	8	Turf	Car	18.4	18.4	27	339	None	None	3- 9-62	C333b	(Westbound)
691	391+00	40	3.0	8	Turf	Car	14.5	None	19	63	None	None	3-16-62	Ac	(Eastbound)
697	279+00	40	3.0	8	Turf	Car	9.5	45.0	40	171	Pipe Culvert and Bridge Guard Rail	Pipe Culvert and Bridge Guard Rail	3-24-62	C33d	(Eastbound)
700	291+60	20	2.0	8	Turf	Truck	1.1	3.4	8	540	Cable Guard Rail	None	3-31-62	C323b	(Eastbound)
726	258+20	40	3.5	8	Turf	Car	3.4	NA	>40	459	None	None	7-25-62	C325d	(Westbound)
727	205+00	4	-0.5	0	Paved	Car	18.4	18.4	4	36	Raised Median	Raised Median	7-31-62	Ad	(Eastbound)
730	291+25	25	1.5	8	Turf	Car	26.6	None	14	39	Cable Guard Rail	Cable Guard Rail	9- 4-62	Ac	(Eastbound)
740	211+40	4	-0.5	0	Paved	Car	NA	NA	NA	NA	Raised Median	Raised Median	11- 3-62	NA	(Westbound) 3 Cars Involved
744	200+00	4	-0.5	0	Paved	Car	11.3	11.3	>4	30	Raised Median	Raised Median	11-10-62	Ad	(Eastbound)
748	265+50	40	4.5	8	Turf	Car	9.5	18.4	18	390	None	None	12- 8-62	B3b	(Westbound)
753	245+00	40	3.0	8	Turf	Car	9.5	None	32	188	None	None	1-12-63	B3c	(Westbound)
757	120+45	40	3.0	8	Turf	Car	26.6	None	28	46	None	None	1-31-63	Ac	(Westbound) Snow Cover on Median

TABLE C2. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (c)	REMARKS
765	169+00	40	3.0	8	Turf	Car	1.6	18.4	25	351	None	None	2- 1-63	B3b	(Eastbound)
766	278+00	40	3.0	8	Turf	Car	11.3	None	36	186	None	None	2- 2-63	Ac	(Eastbound)
768	352+50	40	3.0	8	Turf	Car	18.4	18.4	40	156	None	None	2- 5-63	Ad	(Eastbound) Snow Cover on Median
775	250+20	40	3.5	8	Turf	Car	7.1	None	32	216	None	None	2- 9-63	B3c	(Westbound)
782	163+50	40	3.0	8	Turf	Car	14.5	None	25	340	None	None	2-23-63	C333c	(Westbound) Snow Cover on Median
785	387+00	40	3.0	8	Turf	Car	9.5	None	22	300	None	None	2-26-63	B3c	(Eastbound) Snow Cover on Median
789	169+00	40	3.0	8	Turf	Car	7.1	None	16	98	None	None	3- 9-63	C33c	(Eastbound)
797	149+00	40	3.0	8	Turf	Car	6.4	18.4	9	117	None	None	3-23-63	B3b	(Eastbound)
807	240+00	40	3.0	8	Turf	Truck	18.4	11.3	32	153	None	None	4-16-63	B3b	(Westbound)
818	264+50	40	3.0	8	Turf	Car	7.1	None	15	162	None	None	6-27-63	Ac	(Eastbound)
819	270+00	40	3.0	8	Turf	Car	NA	None	25	200	None	None	6-27-63	C33c	(Eastbound)
820	254+00	40	3.0	8	Turf	Car	26.6	NA	40	255	Box Culvert and Earth Berm	None	6-27-63	Ad	(Eastbound)
821	303+50	40	-0.5	0	Turf	Car	18.4	NA	4	27	Raised Median	Raised Median	6-27-63	Ad	(Eastbound)
835	119+00	40	3.0	8	Turf	Car	4.8	45.0	>40	414	None	None	9-28-63	Ad	(Westbound)
836	135+00	40	3.0	8	Turf	Car	11.3	45.0	>40	147	None	None	9-28-63	Ad	(Eastbound)

TABLE C2. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	DATE REPORTED	ENCROACHMENT TYPE (c)	REMARKS
842	395+00	40	3.0	8	Turf	Car	26.6	45.0	>40	123	None	None	11- 9-63	Ad	(Eastbound)
847	117+00	40	3.0	8	Turf	Car	9.5	1.0	>40	210	None	None	12- 7-63	Ad	(Westbound)
872	180+00	40	3.0	8	Turf	Truck	4.8	None	20	400	Crossover	Crossover	2-26-64	Ac	(Westbound) Snow Cover on Median

TABLE C3.

SUMMARY OF ENCROACHMENT DATA FOR F.A.I. ROUTE 57

(a) Station Number

(b) See Definitions

(c) Encroachment may have been influenced by (1) the vehicle straddling or passing over an obstacle without an actual collision; or (2) the driver's taking evasive action in order to miss an obstacle.

(d) See Encroachment Classification Code, Appendix D

MEDIAN CHARACTERISTICS: WIDTH = 80 ft, DEPTH ≈ 3 ft, SHOULDER WIDTH = 8', TYPE OF SURFACE = TURF

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
1	24+00	Car	45.0	None	40	54	40	54	Earth Berm	Earth Berm	6- 2-63	Ac	Vehicle left roadway to the right before entering median.
2	322+00	Truck	1.6	None	40	468	40	468	Drop Inlet	Drop Inlet	12-21-62	Ac	
3	2680+00	Car	NA	NA	22	156	22	156	Crossover	None	12-21-62	B3c	
4	253+00	Car	8.1	None	20	200	20	168	Drop Inlet	Drop Inlet	2-13-63	Ac	
5	2762+70	Car	19.5	None	22	174	22	99	None	None	2-19-63	Ac	
6	443+00	Truck	5.7	11.5	9	210	9	105	None	None	2-19-63	B3b	
7	113+50	Truck	19.5	None	20	145	20	145	Ditch Checks	Ditch Checks	2-19-63	Ac	
8	97+50	Car	2.0	30.0	12	522	12	372	Drop Inlet	None	2-26-63	B3b	
9	150+30	Car	2.4	7.1	14	423	14	273	None	None	3-12-63	B3b	
10	281+75	Car	3.0	9.6	30	402	30	282	None	None	3-19-63	B3b	
11	306+65	Car	8.1	19.5	15	278	15	186	None	None	4- 2-63	B3b	
12	115+80	Truck	2.1	4.7	40	850	40	324	None	None	4- 9-63	B3b	

TABLE C3. CONTINUED

NUMBER	LOCATION (a)	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		EXTENT OF TRAVEL IN MEDIAN (ft)				MEDIAN OBSTACLES INVOLVED		DATE REPORTED	ENCROACHMENT TYPE (d)	REMARKS
			IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INITIAL (b) LATERAL	INITIAL (b) LONGITUDINAL	INFLUENCE (c)	COLLISION			
13	2464+00	Car	9.6	11.5	7	104	7	33	None	None	4-23-63	B3a	Vehicle left roadway to the right before entering median, traveled in median, then crossed original lanes of travel.
14	3136+10	Car	9.6	None	24	150	24	150	None	None	6- 4-63	Ac	Vehicle left roadway to the right before entering median.
15	133+50	Car	5.2	None	18	310	8	105	Ditch Checks	None	6- 4-63	C33c	
16	360+00	Truck	19.5	None	22	39	22	39	None	None	7-23-63	Ac	
17	2679+50	Truck	3.4	None	20	348	20	300	Drop Inlet	None	7-30-63	B3c	
18	2447+00	Car	19.5	30.0	26	150	26	81	None	None	8- 6-63	B3b	
19	141+38	Car	4.4	30.0	25	297	25	186	None	None	8- 6-63	C333b	
20	202+50	Car	5.7	None	27	318	27	234	None	None	8-20-63	B3c	
21	272+00	Car	2.9	3.6	8	264	8	165	None	None	8-27-63	B3b	
22	128+50	Car	9.6	None	21	198	10	55	None	None	10- 8-63	C33c	
23	NA	Car	11.5	NA	NA	NA	NA	NA	None	None	NA	Ac	
24	297+50	Car	11.5	None	39	270	39	200	None	None	1-28-64	B3c	
25	172+50	Car	5.7	30.0	33	801	33	300	Crossover	None	2-21-64	C333b	
26	NA	Car	19.5	30.0	33	180	33	180	None	None	NA	C32c	

TABLE C4.

SUMMARY OF ENCROACHMENT DATA FOR U.S. ROUTE 66

(a) Location with respect to a physical landmark

(b) Encroachment may have been influenced by (1) the vehicle straddling or passing over an obstacle without an actual collision; or (2) the driver's taking evasive action in order to miss an obstacle.

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	REMARKS
1	2 Mi.S. of Bloomington	40	3.0	5	Turf	Car	4.0	10.0	>40	390	Culvert Headwall	None	
2	N. Edge of Chenoa	40	4.5	6	Turf	Car	4.3	None	26	396	None	None	Vehicle left 100 ft. of skid marks on pavement
3	.25 Mi.N. of Lincoln	28	3.0	6	Turf	Truck	2.9	45.0	23	405	Culvert Headwall	Culvert Headwall	
4A	1.5 Mi. N.of Kickapoo Cr.	40	3.5	8	Turf	Car	9.5	18.4	12	185	None	None	
4B	1.5 Mi. N.of Kickapoo Cr.	40	3.5	8	Turf	Truck	8.1	14.0	20	399	None	None	
5	1.6 Mi. N.of Kickapoo Cr.	40	3.5	6	Turf	Truck	2.9	18.4	21	405	None	None	
7	1 Mi.SW of Dixie Truck Stop	40	3.0	6	Turf	Car	8.1	18.4	14	359	None	None	
8A	2.8 Mi. N. of McClean	40	3.5	6	Turf	Car	7.1	9.5	5	130	None	None	
8B	2 Mi.S. of Dixie Truck Stop	40	3.5	8	Turf	Truck	3.8	11.3	25	450	None	None	
9A	.25 Mi.N. of Funk Grove	40	3.5	6	Turf	Car	1.6	None	28	912	Culvert Headwall	Culvert Headwall	
9B	2 Mi.S. of Bloomington	40	3.0	6	Turf	Car	1.7	1.0	5	305	None	None	
9C	2 Mi.S. of Bloomington	40	3.0	6	Turf	Car	1.2	1.0	2	273	None	None	

TABLE C4. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	REMARKS
9D	2 Mi.S. of Bloomington	40	3.0	6	Turf	Car	4.1	1.0	7	402	None	None	
10	2.9 Mi.S. of Bloomington	40	3.0	6	Turf	Car	3.8	7.1	>40	213	None	None	Vehicle left 80 ft. of skid marks on pavement
11	1.5 Mi. N. of Sherman	40	3.0	6	Turf	Truck	1.9	None	27	385	None	None	
100	3.8 Mi. N. of Lexington	40	3.5	6	Turf	Car	1.1	1.0	15	266	None	None	
101A	4 Mi.N. of Lexington	40	3.5	6	Turf	Car	1.0	2.2	28	421	None	None	
101B	4 Mi.N. of Lexington	40	3.5	6	Turf	Car	4.1	1.3	23	258	None	None	
102	4.3 Mi. N. of Lexington	40	3.5	7	Turf	Car	1.0	1.0	10	138	None	None	
103	4.58 Mi. N. of Lexington	40	3.5	6	Turf	Car	3.0	15.7	7	396	None	None	
104	4.6 Mi. N. of Lexington	40	3.0	8	Turf	Truck	4.8	14.0	5	224	Culvert Headwall	None	
106	1.1 Mi. S. of Chenoa	40	3.0	8	Turf	Car	6.4	14.0	8.5	153	Crossover	None	
107	2.4 Mi. S. of Chenoa	40	3.5	8	Turf	Car	9.5	None	16.5	147	Crossover	Crossover	
108	4.5 Mi. S. of Chenoa	40	3.5	8	Turf	Car	1.4	3.6	2.3	342	None	None	
110A	0.2 Mi. N. of Lexington	40	3.0	6	Turf	Car	4.4	None	8.0	705	None	None	
110B	0.2 Mi. S. of Fort Jesse Rd	30	2.0	8	Turf	Car	4.8	5.0	>30	274	None	None	
111A	Lake Bloomington Crossover Rd	30	-0.5	None	Turf	Car	3.6	9.5	4	165	None	None	

TABLE C4. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	REMARKS
111B	Lake Blooming-ton Cros-sover Rd.	30	-0.5	None	Turf	Car	5.7	5.7	15	210	None	None	
111C	Lake Blooming-ton Cros-sover Rd.	30	-0.5	None	Turf	Car	12.7	NA	>30	200	None	None	
112A	Jct.City 66 N.of Bloom-ington	30	2.0	8	Turf	Car	14.0	4.1	18	182	Sign Post	Sign Post	
112B	Jct.City 66 N. of Bloom-ington	30	2.0	8	Turf	Car	8.1	4.1	8	180	Sign Post	Sign Post	
112C	Jct.City 66 N.of Bloom-ington	30	2.0	8	Turf	Car	2.4	1.0	13	252	None	None	
112D	Jct.City 66 N.of Bloom-ington	30	2.0	8	Turf	Car	2.4	1.0	17	264	None	None	
113	.25 Mi. S. of Towanda	40	3.5	8	Turf	Car	5.7	14.0	26	447	Culvert Headwall	Culvert Headwall	
114	.25 Mi. N. of Towanda	40	3.5	8	Turf	Car	11.3	18.4	>40	184	None	None	
115A	.75 Mi. N. of Towanda	40	3.0	6	Turf	Car	1.6	3.6	3.1	200	None	None	
115B	.75 Mi. N. of Towanda	40	3.0	6	Turf	Car	1.6	1.9	2.6	314	None	None	
116A	.25 Mi. N. of Towanda	40	4.0	6	Turf	Car	4.1	9.5	12	219	None	None	
116B	.25 Mi. N. of Towanda	40	4.0	6	Turf	Car	4.0	9.5	9	249	None	None	
116C	.25 Mi. N. of Towanda	40	4.0	6	Turf	Car	4.0	10.0	10	240	None	None	
117	200 ft. N. of Towanda	40	3.0	6	Turf	Car	18.4	18.4	>40	252	Culvert Headwall	Culvert Headwall	
118	0.3 Mi. S. of Bloom-ington	30	2.0	8	Turf	Car	12.5	11.3	>30	128	None	None	

TABLE C4. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE	TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees) IN	OUT	TRAVEL IN MEDIAN (ft) MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	MEDIAN OBSTACLES INVOLVED INFLUENCE (b)	COLLISION	REMARKS
119A	1.3 Mi. N. of Lexing-ton	40	3.0	8	Turf	Car	1.3	1.7	1.8	182	None	None	
119B	1.35 Mi. N. of Lexing-ton	40	3.0	8	Turf	Truck	2.3	2.1	2.8	206	None	None	
120	4 Mi.S. of Chenoa	40	3.0	8	Turf	Car	3.6	1.0	8.3	550	Crossover	None	
121	1.1 Mi. N. of Chenoa	30	2.5	6	Turf	Car	5.7	11.3	29	940	Culvert Headwall	Culvert Headwall	
122	2.2 Mi. N. of Chenoa	30	3.0	8	Turf	Car	3.4	18.4	22	388	None	None	
123	0.3 Mi. N. of Ill.Rte. 23	30	2.5	6	Turf	Car	21.8	None	22	70	None	None	
124	0.9 Mi. N. of Ill.Rte. 23	30	2.0	6	Turf	Car	7.1	18.4	>30	142	None	None	
125	1.3 Mi. S. of Lincoln	33	3.0	6	Turf	Car	1.5	11.3	>33	287	None	None	
126	0.1 Mi. S. of Lincoln	10	-0.5	None	Turf	Car	5.7	18.4	7	105	None	None	
127	Jct. of Access Rd. to Lincoln	16	-0.5	None	Turf	Car	12.7	8.1	>16	71	Sign Post	Sign Post	
128	4.6 Mi. N. of Ill.Rte. 121	40	3.5	8	Turf	Car	4.4	33.7	>40	168	None	None	
129A	300 ft. N. of McClean Road	40	3.0	5	Turf	Car	8.1	None	26	200	None	None	
129B	200 ft. N. of McClean Road	40	3.0	5	Turf	Truck	1.6	5.7	2.5	145	None	None	
131A	2.6 Mi. SW of Ill.Rte. 126	40	3.0	8	Turf	Car	3.2	40.0	38	556	None	None	
131B	2.6 Mi. SW of Ill.Rte. 126	40	3.0	8	Turf	Truck	1.6	45.0	35	631	None	None	

TABLE C4. CONTINUED

NUMBER	LOCATION (a)	MEDIAN CHARACTERISTICS				TYPE OF VEHICLE	ENCROACHMENT ANGLE (degrees)		TRAVEL IN MEDIAN (ft)		MEDIAN OBSTACLES INVOLVED		REMARKS
		WIDTH (ft)	DEPTH (ft)	SHOULDER (ft)	SURFACE		IN	OUT	MAXIMUM LATERAL	MAXIMUM LONGITUDINAL	INFLUENCE (b)	COLLISION	
132	7.1 Mi. SW of Ill.Rte. 126	40	2.5	8	Turf	Car	14.0	1.0	>40	625	None	None	
133	0.4 Mi. N. of U.S.Rte. 52	40	3.5	8	Turf	Car	18.4	None	35	262	Culvert Headwall	Culvert Headwall	
135	1.3 Mi. S. of Ill.Rte. 129	40	3.0	8	Turf	Truck	1.4	3.4	>40	330	None	None	
136	0.8 Mi. S. of Ill.Rte. 113	40	3.0	8	Turf	Truck	5.7	26.6	25	272	Culvert Headwall	None	
137	4 Mi.S. of Gardner	30	2.5	6	Turf	Car	6.3	26.6	30	72	None	None	
138	2.2 Mi. S. of Gardner	30	2.0	6	Turf	Car	NA	None	17	132	Drop Inlet	Drop Inlet	

TABLE D1.

INVENTORY OF OBSTACLES IN MEDIAN

US 66, CAYUGA TO BLOOMINGTON, ILLINOIS

Mile Section (N.E. to S.W.)	1 Cayuga	2	3	4	5 Ill. Rte. 116	6	7	8	9	10	11	12	13	14	15	16 Chenoa	17	18	19	20	21
Crossovers	4	2	2	1	2	1	1	1	3	2	4	2	1	3	3	2	2	3	3	4	3
Culvert Headwalls	0	0	0	1	0	0	0	1	3	3	3	5	5	6	2	2	4	2	5	5	3
Earth Berms	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
Inlets	0	0	0	0	0	0	1	1	0	1	3	0	0	0	0	0	0	0	0	1	0
Trees ≥ 6" Diam.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mile Totals	5	4	4	2	2	1	2	3	6	6	10	7	6	9	5	6	7	5	8	10	6

Mile Section (N.E. to S.W.)	22	23	24 Lexington	25	26	27	28	29	30	31 Towanda	32	33	34	35 Lake Rd.	36	37	38	39 Ill. Rte. 9	40	41	42 US 150	TOTAL	Average Per Mile
Crossovers	0	2	2	2	2	0	2	2	1	4	1	4	1	2	2	0	3	3	2	2	2	88	2.1
Culvert Headwalls	1	3	2	3	2	2	1	3	3	3	2	4	3	2	0	0	0	0	0	0	0	84	2.0
Earth Berms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.2
Inlets	2	2	0	1	3	2	2	2	2	0	0	0	0	0	0	0	4	2	4	5	2	40	1.0
Trees ≥ 6" Diam.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	6	15	0.4
Mile Totals	3	7	4	6	7	4	5	7	6	7	3	8	4	4	2	0	7	5	12	10	10	235	5.6
Total (disregarding trees on 3 miles near Bloomington)																						220	5.2

F.A.I. 74, DANVILLE TO URBANA, ILLINOIS

Mile Section (East to West)	1 US 150	2	3	4 Oakwood	5	6	7	8	9	10	11 Ill. Rte. 49	12	13	14 Ogden	15	16	17	18 St. Joseph	19	20	21	22	23	24	25	26	27 US 45	TOTAL	Average Per Mile
Crossovers	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	5	0.2
Culvert Headwalls	0	0	2	3	1	2	0	1	2	4	0	3	2	3	4	4	2	2	3	7	4	1	3	0	0	1	1	55	2.0
Earth Berms	1	0	0	0	3	2	4	3	4	3	1	3	1	4	2	2	0	0	0	0	1	0	1	3	5	1	2	46	1.7
Inlets	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0.2
Overpass Supports	2	1	1	1	0	1	1	1	0	1	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	1	1	22	0.8
Mile Totals	4	4	5	4	4	5	5	6	6	8	2	8	3	8	6	7	2	3	4	7	6	3	5	4	7	3	5	134	5.0
Total obstacles that may be readily corrected	2	3	4	3	4	4	4	5	6	7	1	7	3	7	6	6	2	2	3	7	5	2	4	3	6	2	4	112	4.1

This page is intentionally blank.

This page is intentionally blank.

IV. NATURE OF MEDIAN ENCROACHMENTS

A. SIGNIFICANCE

During the past 35 years, median design has gone through an extended period of development involving the trial installation of many different widths and cross sections.(7) The adoption and, in some cases, elimination of these designs has been based primarily upon administrative decisions supported by engineering judgment and a qualitative analysis of the safety and service benefits provided by the median. In practically all cases, the decisions have been made without quantitative data concerning the ability of the median to perform certain important traffic safety functions. One of the primary functions of the median is to serve as a suitable stopping or recovery space for encroaching vehicles and yet, except for the study of median barrier performance, little effort has been made to determine the effects of median width and cross section on the behavior of encroaching vehicles.

The large number of driver and vehicle variables involved makes it impractical to determine theoretically either the behavior of the encroaching vehicle or the changes in vehicle behavior produced by alterations in median cross sections. Only by collecting data concerning actual vehicle behavior during encroachment can an evaluation of various cross sectional designs and characteristics be begun.

The lateral extent of median encroachments can indicate the median width required to provide an appropriate vehicle stopping and recovery space. It can also serve as a measure of the effectiveness of the median cross section in controlling lateral vehicle movement. The length of vehicle travel during encroachment shows the reasonable extent to which the median should be free of obstacles which cannot be traversed safely at normal, highway operating speeds.

B. METHOD

The analysis of the nature of median encroachments was conducted for F.A.I. Routes 74 and 57, described in Appendix D, and was limited to data from unintentional encroachments with lateral movements in excess of

3 feet. Encroachments involving less lateral movement than this were not recorded because of the extreme difficulty of detecting encroachments on the 3-foot stabilized shoulder. During the periods of study, 302 and 26 unintentional encroachments were detected and recorded for F.A.I. Routes 74 and 57, respectively.

In analyzing the physical parameters associated with the encroachment patterns, data from less than the total number of encroachments were generally used. This procedure resulted because certain parameters could not be measured in all encroachments. In addition, only selected portions of the data were considered in certain phases of the analysis. The reasons for this selectiveness are explained in the discussion.

A summary of the information obtained from the analyses of the evidence and conditions at the sites of all unintentional encroachments on the medians of F.A.I. Routes 74 and 57 is presented in Appendix C, and Tables C1, C2, and C3, respectively. In addition to the physical parameters such as angle of encroachment and lateral and longitudinal movements, a coded description of the basic vehicle movement pattern involved in each encroachment is also included. Space limitations prevent the inclusion of a detailed description of each encroachment.

The physical characteristics of the encroachments which generally could be determined from an analysis of field evidence are the basic movement patterns, the angles of encroachment, and the lateral and longitudinal distances of vehicle travel involved in the encroachments. All measurements were made with reference to the path of the left front wheel of the encroaching vehicle. The encroachment angle is defined as the angle between the pavement edge and the path of the left front tire of the vehicle as it departs from the pavement. The lateral extent of movement is defined as the perpendicular distance from the pavement edge to the path of the left front tire of the vehicle at some specified point in the encroachment pattern. The length of travel is the distance from the point at which the vehicle departs from the roadway to some specified point in the encroachment pattern as measured along the left front tire path.

C. FINDINGS AND DISCUSSION

Figure 15 graphically represents the relative number of encroachments exhibiting different basic vehicle movement patterns. These patterns are primarily concerned with movements occurring in the median and are described by means of the previously mentioned encroachment classification code (see Appendix C). The more significant movements and events associated with the encroachments are summarized in Table 3.

The distribution of encroachment angles is shown in Figure 16, which includes the combined data from F.A.I. Routes 74 and 57. This figure represents the encroachment angles for all unintentional encroachments occurring during the periods of study and having lateral movements greater than 3 feet. The equation approximating the distribution is

$$\beta = 10^{(-0.044\theta + 2.057)}$$

where:

θ = encroachment angle, degrees

and β = percentage of θ's greater than or equal to a given θ

It may be noted in Figure 16 that the observed data deviate from the above expression at low encroachment angles, less than about 2°, and high encroachment angles, greater than about 25°. The deviation at low values of θ is attributed to the failure to record shallow encroachments. The deviation at high values of θ is attributed to the possibility that these data may represent a different type of median encroachment; it is doubtful that a vehicle could encroach upon the median at an angle greater than about 25° unless it was traveling at a slow speed, was involved in a relatively severe collision, or was involved in initial movements resulting in running off the pavement to the right. Available data did not allow consideration of the first two possibilities. However, nine median encroachments involved vehicles running off the pavement to the right prior to the actual median encroachment (Table 3). Nine other encroachments involved vehicles entering the roadway from an interchange ramp.

Figure 17 shows the distribution of encroachment angles excluding the angles for the 18 above mentioned encroachments. By eliminating these the deviation from the distribution relationship at high encroachment angles was greatly reduced.

Figure 17 was used to estimate the number of shallow encroachments which occurred on F.A.I. Route 74. The distribution curve in Figure 17 suggests that 45 (17 per cent of 266) shallow encroachments occurred on F.A.I. Route 74 during the period of study.

A summary of the basic statistical parameters associated with encroachment angles is shown in Table 4.

The distribution of lengths of travel during encroachment for F.A.I. Routes 74 and 57 is shown in Figure 18. Since no significant difference appears between the mean lengths of travel, **L**, for the two highways (see Table 4), the data for both highways have been combined into a single distribution relationship in Figure 19. This relationship closely approximates a normal distribution except at very low values of **L**, less than about 60 feet, and very high values of **L**, greater than about 550 feet. This deviation at high values of L may be due to the fact that it was not always possible to determine whether an encroaching vehicle was out-of-control or, for some reason, was purposely being driven on the median.

The mean values of L for F.A.I. Routes 74 and 57 are 293 feet and 292 feet, respectively. Other statistical parameters are summarized in Table 4.

The greater the length of travel the greater the probability that the vehicle will strike a median obstacle such as a culvert headwall, a drop inlet, or a ditch check. On F.A.I. Route 74 there is an average of five such obstacles per mile of median. Figure 20 indicates the percentage of encroaching vehicles that struck obstacles in the median. This includes only those encroachments with lateral movements greater than 8 feet since there are no obstacles on the shoulder.

During the three-and-one-half year study of F.A.I. Route 74, 11.9 per cent of all encroaching vehicles struck obstacles in the median and many other vehicles came close to striking obstacles. Many either straddled or passed between culvert headwalls while others passed smoothly over headwalls with only the tires making actual contact with the obstacle. With as many as 14 encroachments per mile per year at higher traffic volumes (see Chapter III), an average of more than 1.6 vehicles per mile per year could eventually be expected to strike obstacles in the median of F.A.I. Route 74.

The significance of obstacles in the median is even greater than would be indicated by an estimate of the accident costs and injuries resulting directly from collisions with these obstacles. Many of the vehicles that crossed the median on F.A.I. Route 74 apparently were attempting to dodge obstacles. These encroachments were usually characterized by the lack of evidence of any attempt to recover-to-the-right. Only a few of the cross-median encroachments involved an actual collision with an obstacle in the median. As shown in Table 3, only three (5.8 per cent) of the 52 cross-median encroachments involved vehicles striking obstacles. However, of particular significance is the fact that all but five of the cross-median encroachments occurred without a recovery-to-the-right and two of these struck objects which caused the vehicles to go out of control and cross the median.

There is little doubt that, because of the great length of travel of encroaching vehicles, a serious limitation on the value of the median as a safe stopping or recovery space is imposed by obstacles commonly built into it.

The distribution of maximum lateral movements during encroachment is shown in Figures 21 and 22. Figure 21 contains the separate distribution curves for F.A.I. Routes 74 and 57; Figure 22 contains the distribution curve for F.A.I. Route 74 and 57, combined. Since the median of F.A.I. Route 74 has essentially the same cross section as the first 40 feet, this combination of data was considered justified. Basic statistical parameters associated with the lateral extents of movement for both highways are shown in Table 4.

The important aspect of these relationships is the apparent influence of median cross section slopes. Changes in the slope of the distribution curve occur at approximately the same lateral distances as the changes in median cross section slope.

When a vehicle is moving at an angle to the left of its intended path of travel it is brought under control by steering it through a horizontal curve to the right. The slope of the median for the first 20 feet of lateral movement is negative superelevation (24:1 on the shoulder, 4:1 on the side slope) on the curve that the vehicle follows when it is being brought under control.

As shown in Figure 22, the distribution curve is practically horizontal in the interval from 3 to 8 feet of lateral movement (shoulder area), indicating that very few vehicles are brought under control in this area. Relatively few drivers are able to regain control of their vehicle on the shoulder once the left-front wheel of the vehicle leaves the 3-foot, stabilized portion of the shoulder. In the interval from 8 to 11 feet which is the rounded transition from shoulder to back-slope, a much greater percentage of encroaching vehicles are brought under control despite the change from a mild negative slope (24:1) to a severe negative slope (4:1). The relatively large number of recoveries occurring near the shoulder edge is attributed to the reaction time of the driver and vehicle. The shoulder width can be traversed in the time that it takes for the driver to perceive and the vehicle to respond to the driver's natural reaction to correct to the right. Assuming a vehicle speed of 60 mph, an encroachment angle of 7.5°,* and a one-second interval between driver perception and vehicle response, the vehicle would travel laterally approximately 11.4 feet.

In the interval from 11 to 20 feet the slope of the distribution curve is relatively flat, indicating that few encroaching vehicles are brought under control on the greater negative superelevation (4:1) of the median ditch side-slope. At about 20 feet of lateral movement the distribution

---

*The average encroachment angle for vehicles recovering in the interval from 8 to 11 feet of lateral movement.

curve steepens as a result of the positive superelevation provided by the back-slope of the median ditch. Beyond this, at a lateral distance greater than about 32 feet, the distribution curve becomes flatter again as the slope of the shoulder on the opposing roadway provides less positive superelevation on the vehicle recovery curve.

The interesting implication is the possibility of maintaining a relatively steep slope of the distribution curve across the entire width of the median by providing a small negative superelevation such as the 24:1 slope used on the shoulders of F.A.I. Route 74. Such a theoretical distribution is shown in Figure 23.

Figure 23 shows the actual, adjusted, and theoretical distributions of maximum lateral movements for F.A.I. Route 74. The adjusted curve includes the estimated number (45) of shallow encroachments occurring within the 3-foot width of stabilized shoulder. This portion of the distribution curve is substantiated to a certain extent by previous findings on U.S. Route 66.[3] The theoretical curve is an estimate of the distribution of maximum lateral movements that would be obtained if the 24:1 shoulder slope were extended. It was constructed by extending the slope of the adjusted distribution relationship that occurs in the interval from 9 to 11 feet of lateral distance. This estimate is conservative because an even larger percentage of the drivers would probably have regained control of their vehicles in the interval from 8 to 11 feet of lateral movement if the vehicle had not been in an area of high negative superelevation (4:1). The one major limitation of this estimate is that, although the percentage of vehicles reaching the center line of the median would be reduced, the effect of the decreased positive superelevation provided by the median ditch back-slope cannot be evaluated.

Considering this theoretical curve, it appears that almost all of the encroaching vehicles would be brought under control within a lateral distance of about 29 feet. In view of the present trend toward wider medians to reduce headlight glare, the possibility of reducing cross section slopes should be considered and investigated.

Flatter median cross slopes could also allay drivers' fears, and thus result in more safe recoveries from encroachments. On the presently used 4:1 side-slope the driver's natural reaction is to turn sharply to the right at the time when the median cross slope is causing the vehicle to be pulled violently to the left. This probably causes many drivers to over-correct to the right. In Table 3 it may be noted that 13 encroaching vehicles (7 per cent of those recovering to the right) were over-corrected to the right and crossed their former lanes of travel.

Attempts to determine significant relationships between the three basic parameters, angle of encroachment, and lateral and longitudinal encroachment travel distances, were not successful; this was probably due to the large number of variables which could not be measured. Of particular interest, however, was the observation that in the case of 185 (63.1 per cent) of the 293* encroachments on F.A.I. Route 74, the drivers made a recovery-to-the-right.** This figure does not include those drivers who steered to the right in an obvious attempt to dodge a median obstacle and those who stopped in the median without changing the direction of their lateral component of velocity.

Because of the relatively large number of drivers who made a recovery-to-the-right, an attempt was made to determine the relationship between the three basic parameters at the point of initial recovery-to-the-right. The lateral extent of movement at the point of initial recovery-to-the-right is termed the initial lateral extent of movement, X', and the length of travel to this point is termed the initial length of encroachment travel, L'. Data from those encroachments in which a driver made a recovery-to-the-right are related in Figure 24. The equation approximating this relationship is shown below:

$$\Phi = 2.10 + 0.64$$

where:

Φ = angle between pavement edge and the line connecting the initial point of recovery with the point of the beginning of the encroachment

and θ = encroachment angle

A second form of the equation is:

$$\frac{X'}{L'} = \sin(2.10 + 0.64\theta)$$

where:

X' = initial lateral extent of movement

L' = initial length of encroachment travel

Although the above regression line is highly significant, the correlation coefficient indicates a large amount of deviation from the regression line. Thus, although a definite relationship between θ and Φ appears to exist, it cannot be used to obtain a reliable prediction of the area of vehicle recovery. For any given encroachment angle, a wide range of lateral and longitudinal encroachment travel distances may be expected.

D. CONCLUSIONS AND RECOMMENDATIONS

Because of the wide range of lateral and longitudinal encroachment travel distances

---

*For 9 of the 302 encroachments there was not sufficient evidence to determine the exact nature of the encroachment.

**See Glossary.

that may be expected for any given encroachment angle, a wide range of lateral velocity components must be considered in the design of median barriers to achieve safe vehicle deceleration rates.

Flatter median cross slopes would be a means of (1) decreasing the maximum lateral extent of movement of encroaching vehicles and (2) decreasing the frequency of erratic vehicle re-entry to the traffic stream as a result of over-correction to the right on the median cross slope.

Obstacles commonly built into the median in the form of culvert headwalls, drainage inlet structures, earthen ditch checks, and crossover embankments place a serious limitation on the value of the median as a safe vehicle stopping or recovery space. The median appurtenances represented by these obstacles should be (1) decreased to the smallest practical number and (2) designed to present the least possible hazard to the passage of vehicles entering the median at speeds comparable to normal highway operating speeds.

A 30-foot wide obstacle-free median with mild cross slopes* appears to be the desirable minimum standard for the relatively safe stopping or control of vehicles encroaching on rural highway medians. The installation of suitable median barriers on the basis of traffic volume warrants[6] should be considered when these provisions cannot be made. Allowance must also be made for any additional width needed to provide space for planting, glare screens, or the horizontal separation of roadways to reduce headlight glare.

---

*A 24:1 slope for a 30-foot wide median and steeper allowable slopes for greater median widths.

V. CAUSES OF ENCROACHMENTS

A. INTRODUCTION

This discussion concerns the factors causing or influencing vehicle encroachments on the median of 24.6 miles of F.A.I. Route 74 between Champaign and Danville, Illinois, during the three-and-one-half year period, October 4, 1960 through April 6, 1964.

Emphasis on the frequency and nature of median encroachments has been appropriate in the foregoing discussion, but that emphasis must be accompanied by a perspective of the conditions under which the 302 observed encroachments occurred.

Over 6 million vehicle trips were made on this highway segment during the three-and-one-half years of study; less than 1/5,000 of 1 per cent involved a vehicle encroachment upon the median. Obviously then, the individual driver, vehicle, and highway factors leading to the encroachments are normally so subtle that they seriously affect only one trip in 10,000.

The driver is the ultimate variable because he is the conscious and subconscious sensor of landscape, vehicles, roadway alignment, weather, fatigue, light conditions, pavement surface conditions, and most other factors involved in erratic vehicle movements. To completely understand the driver would be to completely understand man himself, a goal beyond the reach of man's capabilities. However, because of the relatively large number of median encroachments observed in this study, it was possible to recognize certain factors that had rather consistent overriding effects on driver behavior. Among these are light conditions, fatigue, roadway alignment, weather, roadside signs, grade separation structures, and terrain features (landscape). The apparent effects of these are stated below in terms of number of encroachments or percentage of total encroachments.

The average number of encroachments observed per unit length of highway becomes quite small when only 500 or 1,000 feet of highway are being considered in connection with a curve, roadside sign, or interchange ramp. During the three-and-one-half years of study an average of only 2.325 encroachments per 1,000 feet of highway occurred. With such a small average number no appropriate statistical test of the significance of three, four, or even ten encroachments can be made within any given 1,000-foot length of highway. Therefore, statistical tests were applied only when factors involved the entire length of the study section.

B. LIGHT CONDITIONS AND FATIGUE

A strip map of the 24.6-mile study section (see Map 4) illustrates roadway features, pavement station numbers, and the exact location of each of the 302 observed encroachments. The identification number for each encroachment is located next to the roadway from which the encroachment originated.

Cursory examination of the strip map reveals that a majority of the encroachments originated from the westbound traffic stream (58 per cent). Chi-square testing of this deviation from the expected even distribution by directions (151 eastbound and 151 westbound) shows that this difference is significant.*

Drivers in the westbound traffic stream face the sun in the afternoon when they are most likely to be fatigued from the day's activities, while eastbound drivers face the sun at the beginning of the day when they are most likely to be refreshed. If these circumstances explain the observed difference in number of encroachments from the two directions of travel, then the previous conclusions regarding vehicle caravanning would suggest that this difference should diminish as the volume increases. The gradually increasing number of vehicles in the westbound traffic stream should provide progressively better roadway delineation to offset the effects of driving into the afternoon sun.

This line of reasoning is supported by the encroachment data. Figure 25 shows how the separate median encroachment rates for the two directions of travel varied with traffic volume. The westbound rate, originally much higher than the eastbound rate, decreased rapidly in the volume range of from 4,000 to 5,000 vehicles per day and eventually nearly equaled the eastbound rate. Apparently, the increasing number of vehicles in the traffic stream eventually provided enough roadway delineation to offset the effect of driving into the afternoon sun.

Another possible effect of fatigue is indicated by the distribution of encroachments along the 24.6-mile study section. A relatively high percentage of encroachments occurred near the west end of the study section for the westbound traffic stream and near the east end for the eastbound traffic stream.

Slightly over 22.5 per cent of all

*Significant at the 99 per cent level.

encroachments originating from each traffic stream occurred on the last four miles (16.25 per cent of mileage) at the downstream end. This percentage includes those encroachments (ten eastbound and ten westbound) resulting from entrance ramp friction at the upstream end for each direction of travel. If those encroachments are not considered, the percentage of encroachments occurring on the last four miles in each direction of travel is raised to 24. Many different fatigue-related factors such as decreased alertness, velocitation, and lowered visual acuity are undoubtedly involved in this downstream distortion of encroachment distribution.

C. WEATHER

Weather is partially responsible for the difference in the observed number of encroachments in the two directions of travel. The prevailing wind and storms come from the westerly direction in central Illinois. Westbound vehicles are normally subjected to much higher wind velocities (travel speed plus wind speed) than are eastbound vehicles (travel speed minus wind speed). This difference in air-stream velocities magnifies the effect of windbreaks such as overpass abutments, roadside tree planting, etc., on westbound vehicles.*

*Drag varies with the square of air-stream velocity.

The hardest driven rain and snow storms are from the west. Snow and rain, therefore, accumulate more rapidly on the windshields of westbound vehicles, resulting in poorer driver visibility.

Some of the variation shown in Figure 6 is due to weather changes. The number of encroachments during April, May, and June varied greatly over the three calendar years, 1961, 1962, and 1963. In 1961, this three-month period was marked by temperatures averaging 4.4 degrees below normal and precipitation averaging 1.81 inches above normal. During this cold, wet weather in the spring of 1961 nearly three times more encroachments were observed than during the same three-month period in 1962 when the temperature averaged 2.1 degrees above normal and the precipitation averaged 0.78 inches below normal. The same three-month period in 1963 brought a further decrease in number of encroachments with temperature 0.9 degrees above normal and precipitation 2.31 inches below normal.

Weather differences and traffic volume increases are both partially responsible for the rapid decrease in median encroachment rate during 1962. The relative effects of each cannot be accurately judged. Nevertheless, the continued low encroachment rate after the spring of 1963 under normal weather conditions suggests that increasing traffic volumes would have eventually brought about the same reduction in encroachment rate even without improved spring weather. Therefore, traffic volume increases are assumed to have produced most of the reduction in encroachment rate which occurred in 1962.

The above assumption has no important effect on Figures 2 and 3. An adjustment of the data to account for the effects of spring weather would merely broaden the apex of the curve in Figure 2 and steepen the sharp downward slope of the curve in Figure 3.

D. INTERCHANGES

Six interchanges were involved in the 24.6-mile study section: four diamond interchanges and a trumpet interchange at each end. The number of encroachments at each interchange and in the vicinity of each interchange ramp was compared with the average number of encroachments per equivalent unit length of highway.

No significant variation in number of encroachments could be attributed to any of the interchanges as a whole, regardless of the length of highway considered to be within the area of influence. Assuming an area of influence extending 500 feet beyond the entrance and exit ramps, the interchanges represent 16 per cent of the length of the highway within which only 13.8 per cent of the median encroachments occurred.

When each interchange ramp is considered separately, three locations appear to have significant concentrations of encroachments: (1) the entrance ramp for eastbound vehicles at the west end of the study section (station 420 + 00), with ten encroachments; (2) the exit ramp for westbound vehicles at Ogden, Illinois, (station 1017 + 50), with nine encroachments; (3) the entrance ramp for westbound vehicles at the east end of the study section (station 1685 + 00), with ten encroachments.

The reasons for the concentration of encroachments near the Ogden exit ramp are not known. Eight of these encroachments occurred during the first 1½ years of surveillance and only one occurred during the remaining two years.

The concentration of encroachments near the entrance ramp at the east end of the study section (station 1685 + 00) is a result of excessive vehicle entry speeds. Only two encroachments have occurred there since an advisory speed sign was installed on the ramp in November, 1962, (see Figure 26).

Excessive vehicle entry speeds are only partially responsible for the ten encroachments near the entrance ramp at the west end of the study section (station 420 + 00). The overpass structure (station 431 + 00) and roadside sign (station 445 + 00) immediately downstream from the ramp are believed to be equally important if not controlling factors at this location. Consequently, no effort has been made to control vehicle speeds on this entrance ramp.

E. GRADE SEPARATION STRUCTURES

Within the 24.6-mile study section 18 grade separation structures carry state highways and local roads over F.A.I. Route 74. Four of these are at the diamond interchanges mentioned previously. These structures serve as windbreaks, the effects of which can be seen in the distribution of encroachments.

For an assumed area of influence extending 800 feet up-stream from each structure, the combined length of influence area for all 18 grade separation structures is 11.1 per cent of the length of the study section. This area of influence contains 16.2 per cent of the encroachments originating from the westbound traffic stream and only 8.7 per cent of the encroachments originating from the eastbound traffic stream. This is evidence of the effect of the prevailing west wind as discussed above in connection with weather.

If this same analysis is made for 800-foot downwind* areas of influence at each grade separation structure, the distribution becomes more nearly the same for both directions of travel. The combined influence areas contain 16.2 per cent of encroachments originating from the westbound traffic stream and 13.4 per cent of encroachments originating from the eastbound traffic stream.

Grade separation structures serve as windbreaks which cause erratic vehicle movements on the pavement downwind from the structures. Encroachments result only when these erratic movements are accompanied by conditions such as driver inattentiveness, lack of driver alertness, poor visibility, and wet, icy, or snow-covered pavement surface. These necessary combinations rarely occur, but erratic vehicle movements can be observed downwind from the structures on any relatively windy day.

F. ROADSIDE SIGNS

Erratic vehicle movements on the pavement were also observed in the vicinity of large roadside signs. Vehicles apparently veer away from the signs as illustrated in Figure 27. This particular sign faces westbound traffic and, therefore, serves as a small windbreak for vehicles heading into the prevailing west wind. The absence of a heavy snow accumulation on the roadside immediately downwind from the sign indicates the area of greatest air turbulence. It may be noted that the beginnings of most of the erratic vehicle movements coincide with the downwind limits

*Downwind from the prevailing west wind.

of this area of high air turbulence.

Three series of observations were made at the location shown in Figure 27. The results, presented in Table 5, show that slightly over 30 per cent of the vehicles shifted to the left in the vicinity of the sign. Lateral movements normally ranged from 2 to 4 feet, with the maximum lateral movement usually occurring about 500 feet up-stream from the sign. However, some vehicles changed lanes from right to left in the vicinity of the sign and subsequently returned to the right-hand lane. Others shifted to the left at a considerably greater distance up-stream from the sign, beyond the limits of the area affected by high air turbulence.

Six encroachments in the vicinity of this sign (station 1225 + 00) were probably influenced by such erratic vehicle movements on the pavement. Many other small concentrations of encroachments are associated with roadside signs throughout the length of the study section for both directions of travel (see Map 4). However, the greatest effect, in terms of encroachments, appears to be at locations where a roadside sign occurs about 1,500 feet down-stream from a grade separation structure.

One such location, immediately down-stream from the entrance ramp at the west end of the study section, was discussed above in connection with the effects of interchange ramps. Six of the first nine encroachments down-stream from this entrance ramp were probably influenced by the roadside sign at station 445 + 00. A grade separation structure occurs just up-stream from this sign, but it is far enough up-stream that its effect as a windbreak could not have been responsible for encroachments near the sign. The abutment of the structure hides the sign from the driver's view until he is within about 2,500 feet of the sign. Then, as the sign begins to appear within the landscape viewed by the driver, it gives a subtle impression of having moved out toward the roadway from behind the abutment. This seems to make no conscious impression on the driver. All test drivers who were rightfully accused of having shifted to the left, either emphatically denied it or claimed that they were not aware of having done so in the vicinity of the sign. Some were unsuspecting members of the research project staff who were aware of this phenomenon, but who were driving over the study section for other reasons.

Current practice with regard to placement of roadside signs should be reviewed in the light of these observations. Large roadside signs should be located as far down-stream from overpass structures as is practical. Smaller signs, such as those giving distances to various cities, appear to have considerably less effect on driver-vehicle behavior.

G. CURVES

Of the seven horizontal curves wholly within the 24.6-mile study section, so many are accompanied by large roadside signs that the effects of the curves and signs cannot be separated. Nevertheless, roadside signs do appear to have some effect on the frequency of encroachments in the vicinity of horizontal curves. If the two longest curves near the middle of the study section are compared, it can be seen that about 2.5 times as many encroachments occurred at the curve accompanied by large roadside signs.

A similar difference in numbers of encroachments is noted in a comparison of the relatively short curve that has a large sign, at station 1560 + 00, with the other three curves of similar length that are not accompanied by large roadside signs, stations 630 + 00, 960 + 00, and 1360 + 00. Curves and the approaches to curves should be avoided as locations for large roadside signs.

Curves, per se, do not appear to greatly affect encroachment frequency. For an assumed area of influence extending from the beginning of each curve to a point 500 feet down-stream from the end of each curve, the combined length of influence area for all curves represents 15.1 per cent of the mileage of the test section, within which 15.1 per cent of the encroachments occurred.

Without the effects of roadside signs, the curves might possibly have been the safest sections of roadway. Curves without roadside signs appear to be in areas where encroachments are thinly scattered, especially the areas from station 600 + 00 through 685 + 00 and from station 1330 + 00 through 1375 + 00.

H. TERRAIN FEATURES (LANDSCAPE)

It is interesting to note that several of the other areas with thinly scattered encroachments are up-stream from groves of trees that serve as dominant terrain features and delineate roadway alignment. Two examples in connection with the eastbound traffic stream are the areas from station 650 + 00 through 775 + 00 and from station 1250 + 00 through 1350 + 00. The areas from station 1450 + 00 through 1410 + 00 and from station 790 + 00 through 740 + 00 are similar examples for the westbound traffic stream.

Roadside clumps of trees do seem to be beneficial as roadway delineators. However, the concentrations of encroachments down-stream from some of these locations must not be overlooked.

When particularly thick clumps of tall trees are encountered, such as at stations 740 + 00 and 1610 + 00, the down-stream windbreak effect largely offsets the up-stream delineation benefits, resulting in no net reduction in encroachments. Consideration should be given to the need for thinning and/or pruning trees outside the limits of the highway right-of-way. Particular attention should also be paid to landscaping grade separation structures with types of plantings that will not accentuate the windbreak effects.

I. SUMMARY

In view of the many different highway, driver, and vehicle variables that may be assumed to cause or inhibit encroachments, it is not possible to assign a specific cause to any given concentration of encroachments. The foregoing discussion merely emphasized those features of the driving environment which were most often associated with encroachments. In some cases it appears as though an adjustment of features would be both desirable and practicable. The following recommendations are made:

(1) Curves, the approaches to curves, and the areas immediately down-stream from grade separation structures should be avoided as locations for large roadside signs; safety benefits that might accrue from the use of overhead rather than roadside signs should be thoroughly investigated.

(2) More emphasis should be placed on landscape planting to improve delineation of roadway alignment; however, attention should be given to control of the windbreak effects of all roadside plantings, both inside and outside the right-of-way limits.

(3) The adverse windbreak effects of grade separation structures should be considered in connection with the other factors affecting the number and location of such structures; landscape planting, structure modifications, and other possible means of controlling these windbreak effects should be thoroughly studied.

VI. APPENDICES

A. METHODS OF VEHICLE ENCROACHMENT DETECTION INVESTIGATION

Because of the large personnel, time, and cost requirements of the chosen method of data collection, other possible methods were investigated. Among these were the use of airphoto techniques and electronic detection equipment.

During the summer of 1960, airphoto techniques, employing both black and white and infrared film, were investigated as possible means of rapidly and economically collecting data on the behavior of vehicles encroaching upon the median. It was anticipated that the difference in texture and moisture content of median soil crossed by vehicle tires would outline the paths of encroaching vehicles on infrared photographs. These efforts met with very limited success. Infrared photography provided the needed information only when the encroachment occurred on median soil containing a moisture content high enough to allow some compaction to take place and yet not so high as to mask the effect produced by compaction. The use of black and white film was completely unsuccessful.

In 1959, work toward development of a semi-automatic system for the detection of vehicles encroaching upon medians of divided highways was begun in co-operation with Professor Milton H. Crothers of the Department of Electrical Engineering of the University of Illinois. This work was based on the fact that a vehicle passing over a balanced pair of buried wire loops produces a measurable change in loop balance (inductance and resistance). An attempt was made to obtain an accurate means of measuring this imbalance to record the time of day of the encroachments and the speed of the vehicles.

In the summer of 1959, an initial installation was made on Illinois Route 47 north of Gibson City. Various types and sizes of coils were embedded in an asphaltic concrete overlay. Two circular coils, 30 inches and 13 inches in diameter, and one rectangular coil, 3 feet by 6 feet, were tested. The test installation is shown in Figures A1 and A2.

These tests indicated that good bridge imbalance response could be obtained with a single turn loop coil using frequencies in the region of 0.5 megacycles. There did not appear to be any advantage in using multi-turn coils.

In October, 1961, tests were made using a large single-turn coil, 4 feet by 50 feet, embedded in earth. The purpose of this test was to observe the behavior of the system in the soil and to extend the area covered by the detection system.

A single-turn coil of standard plastic coated electrical wire was used. At a frequency of 0.45 Mc. using a GR-916AL Bridge and a GR-1330 Bridge Oscillator, the following values were obtained:

Coil alone

$$R = 29.5 \text{ ohms}$$

$$X = +j\ 262 \text{ ohms}$$

Car across the loop at an angle of 45°

$$\Delta R = 3.3 \text{ ohms}$$

$$\Delta X = +j\ 3.3 \text{ ohms}$$

Car across the loop at an angle of 90°

$$\Delta R = 3 \text{ ohms}$$

$$\Delta X = +j\ 5.3 \text{ ohms}$$

where:

R = resistance,

X = reactance, and

j = complex operator

The relative sensitivity (as indicated by the GR-1212-A Null Detector on a semi-log type volt meter scale) was much less on these large coils than on the small coils embedded in the asphaltic concrete overlay. The reduction in relative sensitivity was attributed to the fact that the car does not cover the entire loop. For this reason it was felt that the loop length could not be increased.

A pilot model of a small r-f bridge circuit was constructed to take advantage of a pair of coils so that a length of 100 feet could be covered by one system. It was felt that the use of a balanced pair of coils would reduce stray differential effects such as are caused by temperature and moisture variations.

The frequency of 0.45 Mc. was chosen so that the i-f amplifier and detector sections of a small, inexpensive transistor radio receiver could serve as a detector amplifier for the system. The r-f source signal was obtained from a transistor oscillator. Figure A3 is a schematic representation of the equipment and the system. A small capacitor, in series with each coil, tuned out most of the coil's reactance. Much of the equipment used in this system was made in the Electrical Engineering Department Laboratory. This homemade equipment was found to have much less sensitivity than commercial equipment.

This system functioned very well during the summer of 1962; however, at temperatures below freezing the system did not function satisfactorily. This difficulty was attributed to excessive ground losses occurring as a result of the change in dielectric properties of soil moisture upon freezing. Since overcoming this difficulty would have required additional personnel, facilities, and money which were not available, work in this area was terminated.

B. VEHICLE ENCROACHMENT REPORT

1. Front of Vehicle Encroachment Report Form

Exact Location:

Section Key ____________________

Location No. ____________________

Date ____________________

Route ____________________

Recorder ____________________

Speed Limit: Type of Vehicle Involved:

Median Dimension: Width Depth Shoulder Width Type of Cover

No. of Observed Incidents: Angle of Encroachment: IN $\tan \alpha =$, $\alpha =$
OUT $\tan \alpha =$, $\alpha =$

Median Appurtenances (of possible influence):
(involved in collision):

Exact Extent of Vehicle Braking:

Max. Lateral Movement: (from left pavement edge) (from right pavement edge)

<u>Sketch</u> and <u>written</u> description of incident, location and factors involved. (Show all dimensions)

2. Back of Vehicle Encroachment Report Form

Accident Reported: Yes No By Whom Date Accident Occurred:

Location Reported:

Weather Conditions when Accident Occurred:

(Evidence of Damage at Accident Site)

Estimate of Damage: Reported Estimate:

Apparent <u>irregularity</u> or <u>omission</u> in Accident Report, if any:

C. ENCROACHMENT CLASSIFICATION CODE

All median encroachments were divided into three general classifications (A, B, and C) and several subclasses in order to provide a form of data conducive to processing and analysis. This classification deals only with the encroachment after the vehicle first enters the median and is not concerned with how the initial entry was caused.

In Type A encroachments the lateral component of velocity of the vehicle apparently never changes direction after the vehicle leaves the pavement. The small letter following the A indicates the zone in which the vehicle is stopped or apparently brought under absolute control (see Figure C4 for code of zones). For an example of an Ae encroachment see Figure C1.

The lateral component of velocity of the vehicle is changed once and only once in Type B encroachments. The number following the B indicates the zone in which this change occurs and the small letter indicates the zone in which the vehicle is stopped or apparently brought under absolute control. See Figure C2 for an B4b encroachment.

Type C encroachments have lateral components of velocity which change direction two or more times. The numbers following the C indicate the respective zones in which these changes take place. Since there are only five zones, there is no danger of interpreting 12 as twelve, etc. Examples are presented in Figure C3.

The five zones are numbered and lettered from the driver's right to his left as shown in Figure C4.

D. DISCUSSION AND DESCRIPTION OF HIGHWAY SEGMENTS

The rural Illinois highway segments chosen for study were F.A.I. Route 74 between Champaign and Danville, U.S. Route 66 between Chicago and Springfield, and F.A.I. Route 57 between Marion and Wetaug (see Maps 1, 2, and 3).

In general F.A.I. Route 74 and U.S. Route 66 have dual 24-foot roadways separated by a depressed 40-foot turf median (see Figures D1, D2, D8, and D9). Median widths from 12 to 64 feet are included in a limited portion of U.S. Route 66 from Chicago to Springfield, Illinois; but the majority of the data obtained was for the predominate 40-foot depressed median.

F.A.I. Routes 57 and 74 and the first 40 miles of U.S. Route 66 southwest of F.A.I. Route 294 have complete control of access. The other 140 miles of U.S. Route 66 from Dwight to Springfield have partial control of access and many intersections at grade.

The average daily traffic volume on

U.S. Route 66 between Springfield and Chicago has grown from 6,200 in 1956 to 8,200 in 1960. F.A.I. Route 74 between Urbana and Danville was opened to traffic on October 4, 1960, and was carrying an average of 1,724 vehicles per day during the first week of November, 1960. By May 1, 1962, the volume had grown to about 6,000 vehicles per day where it has remained through April 6, 1964.

The many crossover embankments, culvert headwalls, raised concrete drainage inlets, and earth berms are employed as ditch checks in the medians of these highways. Such appurtenances serve as obstacles to the use of the median as a stopping or recovery space for erratically moving vehicles. As shown in Table D1, there is an average of five or more such obstacles per mile of median on F.A.I. Route 74 and U.S. Route 66. Some examples of these are presented in Figures D1 through D7.

F.A.I. Route 57 study sections, between Marion and Wetaug, have dual 24-foot roadways separated by an 80-foot, double-ditch median 3 feet in depth (see Figures D10 and D11). Traffic volumes on this highway during the period of study were relatively low (less than 2,000 vehicles per day). The terrain crossed by F.A.I. Route 57 is very rolling in comparison with the nearly level terrain crossed by U.S. Route 66 and F.A.I. Route 74.

The urban highways chosen for study were portions of Edens, Calumet, and Kingery Expressways in the Chicago area. The collection and analysis of data from Edens and Calumet Expressways were part of a previously reported study on the effects of roadway delineation as measured by the change in frequency and rate of median encroachment.(4)

Kingery Expressway has two-lane dual roadways separated by an 18-foot turf median with a ditch approximately 6 inches deep (see Figures D12 and D13). During the period of this study, the median had a 3/4-inch, single-strand cable barrier* suspended on wooden posts spaced 20 feet on centers. This barrier was intended to serve as a deterrent to intentional U-turns across the median and not necessarily as a barrier to the cross-median movement of erratically moving vehicles.

Kingery Expressway is unlighted and has essentially tangent alignment. The pavement is kept relatively free of snow and ice. Drainage of rain and melted snow is hastened by V-type gutters on the edge of the pavement next to the median.

E. DISTRIBUTION OF VEHICLE HEADWAYS ON F.A.I. ROUTE 74

The distribution of headways at

---

*A continuous guardrail barrier was installed in the Kingery Expressway median after the data for this study were obtained.

various ADT volumes on F.A.I. Route 74 (Figure 14) was calculated from the data represented in Figures 12 and 13.

Figure 12 represents the average distribution of expanded 15-minute volumes on F.A.I. Route 74 expressed as a percentage of ADT. This relationship was developed from the ten traffic counts (Chapter III) obtained on F.A.I. Route 74 over the three-and-one-half years of study. Each traffic count consisted of four one-direction counts. Six of the one-direction counts, chosen at random and representing both ends of the highway, both directions of travel, and a variety of seasonal conditions during the period of study, were used. The relationship in Figure 12 is the average of these six curves. The maximum deviation from this average line was 7 per cent for any one of the six individual distribution curves.

Figure 13 represents the average distribution of headways (seconds) in a 15-minute interval expressed as a function of the expanded 15-minute volume. Sixty-seven 15-minute observations were made between June and December, 1964. These observations were made at all times of day and under a variety of weather conditions. The equation approximating the relationship in Figure 13 is shown below.

$$Z = \left[10^{-2.43\ TV\ (10^{-6})} \right] 100$$

where:

- T = headway, seconds
- V = expanded 15-minute volume (15-minute Vol. x 192), vehicles per day
- Z = percentage of T's equal to or greater than a given T

In addition to F.A.I. Route 74 observations, one 15-minute observation from Kingery Expressway is included for purpose of comparison.*

Figure 14 represents the distribution of headways at various ADT volumes. This relationship was constructed using the data and relationships shown in Figures 12 and 13.

---

*Expanded volume for the 15-minute observation on Kingery Expressway is 66,048 vehicles per day.

VII. REFERENCES

1. Hutchinson, J. W., Scott, W. A., and Kennedy, T. W., "Medians of Divided Highways--Current Status of Knowledge and Annotated Bibliography," Highway Research Board Bibliography 34. Washington, D.C.: National Academy of Sciences/National Research Council, 1963.

2. Hutchinson, J. W., and Kennedy, T. W., "Use of Accident Records in Highway Research," Highway Research News, No. 13 (June, 1964), pp. 1-8.

3. Hutchinson, J. W., "The Significance and Nature of Vehicle Encroachments on Medians of Divided Highways," (Civil Engineering Studies, Highway Engineering Series No. 8). Urbana, Ill.: Department of Civil Engineering, University of Illinois, December, 1962.

4. Hutchinson, J. W., and Lacis, J., "An Experiment with Evergreen Trees in Expressway Medians to Improve Roadway Delineation," a paper presented at the meeting of the Highway Research Board, January, 1965.

5. Moskowitz, K., and Schaefer, W. E., "Barrier Report," California Highways and Public Works, Vol. 40, Nos. 9-10 (September-October, 1961), pp. 18-24.

6. "Highway Guardrail," Highway Research Board Special Report 81. Washington, D.C.: National Academy of Sciences/ National Research Council, 1964.

7. Hutchinson, J. W., Kennedy, T. W., and Surman, H. E., "History of Median Development in Illinois," a paper presented at the meeting of the Highway Research Board, January, 1965.

This page is intentionally blank.

PUBLICATIONS OF THE COLLEGE OF ENGINEERING

Bulletins from the University of Illinois College of Engineering are detailed reports of research results, seminar proceedings, and literature searches. They are carefully reviewed before publication by authorities in the field to which the material pertains, and they are distributed to major engineering libraries throughout the world. They are available at a charge approximately equal to the cost of production.

The annual *Summary of Engineering Research* is available in the fall of each year. It contains a short report on every research project conducted in the College during the past fiscal year, including the names of the researchers and the publications that have resulted from their work. It is available free of charge.

Engineering Outlook, the College's monthly newsletter, contains short articles about current happenings, new research results, recent technical publications, and educational practices in the College of Engineering. Free subscriptions are available upon request.

The Seminar and Discussion Calendar, which is published and distributed weekly, lists current meetings, lectures, and other events on the engineering campus that are open to the public. Free subscriptions are available upon request.

Requests for a catalog of available technical bulletins or for any of the above publications should be addressed to the Engineering Publications Office, College of Engineering, University of Illinois, Urbana, Illinois 61801.